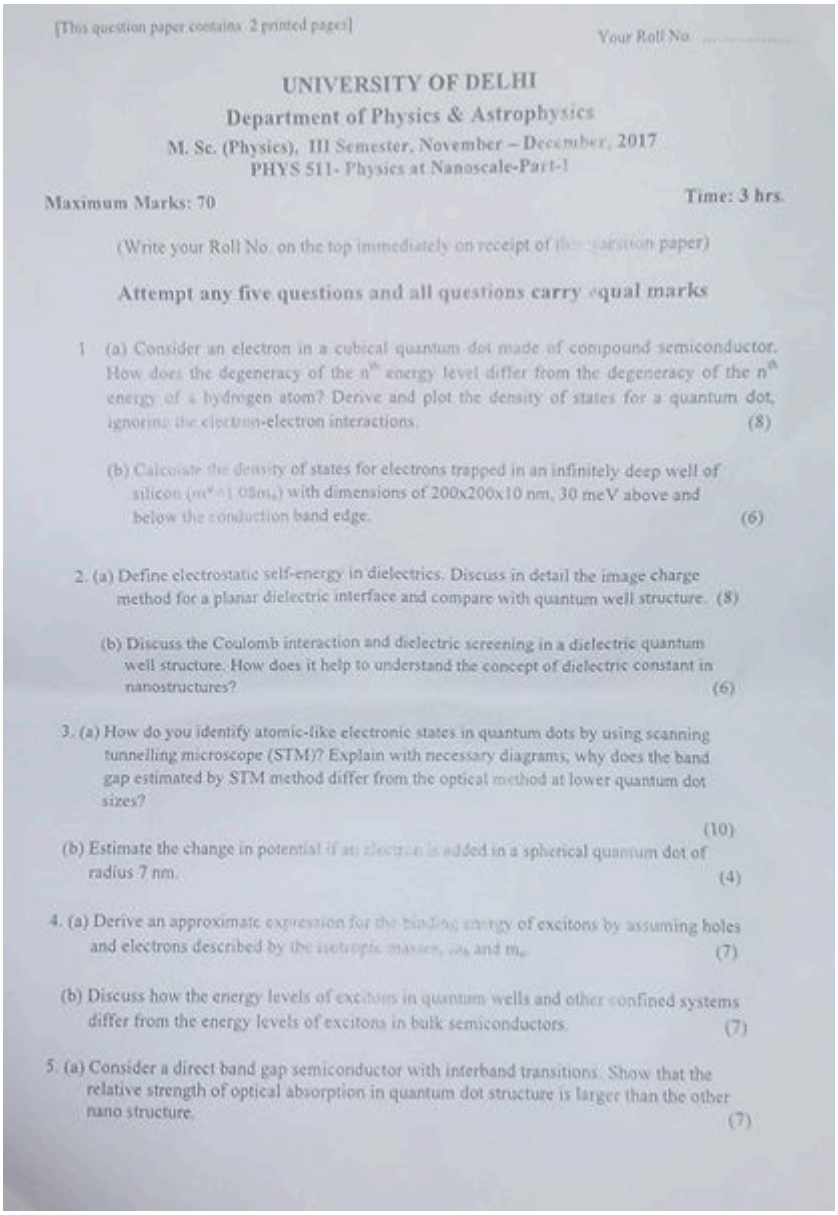
I am posting here the question Paper for the subject: Physics at Nanoscale (Theory I) for the III semester year 2017.
The question paper is for the students of M.Sc Physics at the University of Delhi.

Future students taking this course might find it helpful.



[This question paper contains 2 printed pages]

Your Roll No. .....

UNIVERSITY OF DELHI

Department of Physics & Astrophysics

M. Sc. (Physics), III Semester, November – December, 2017

PHYS 511- Physics at Nanoscale-Part-1

Maximum Marks: 70 **Time: 3 hrs.**

(Write your Roll No. on the top immediately on receipt of this question paper)

Attempt any five questions and all questions carry equal marks

1 (a) Consider an electron in a cubical quantum dot made of compound semiconductor. How does the degeneracy of the n^{th} energy level differ from the degeneracy of the n^{th} energy of a hydrogen atom? Derive and plot the density of states for a quantum dot, ignoring the electron-electron interactions. (8)

(b) Calculate the density of states for electrons trapped in an infinitely deep well of silicon ($m^* = 1.08m_e$) with dimensions of 200x200x10 nm, 30 meV above and below the conduction band edge. (6)

2. (a) Define electrostatic self-energy in dielectrics. Discuss in detail the image charge method for a planar dielectric interface and compare with quantum well structure. (8)

(b) Discuss the Coulomb interaction and dielectric screening in a dielectric quantum well structure. How does it help to understand the concept of dielectric constant in nanostructures? (6)

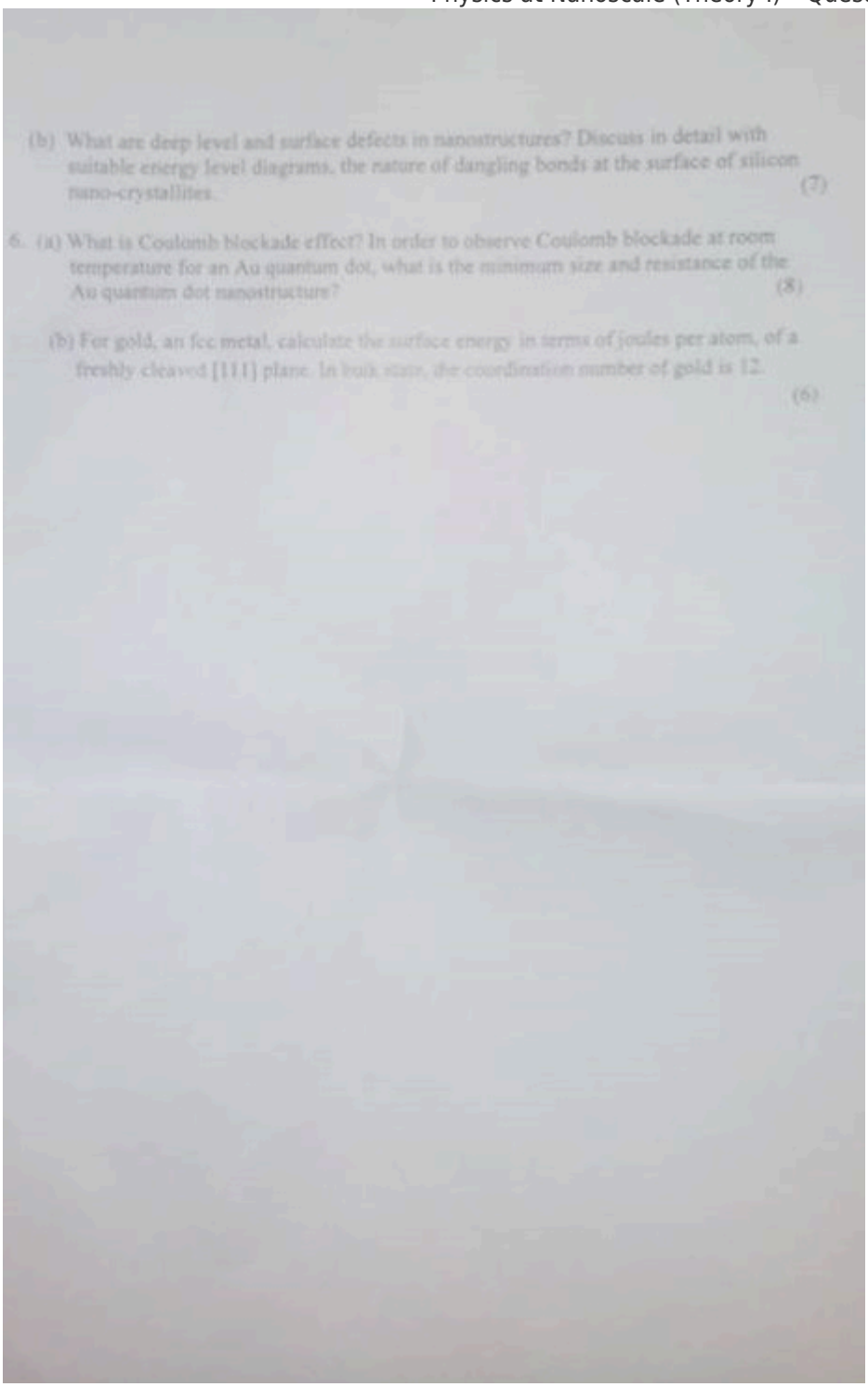
3. (a) How do you identify atomic-like electronic states in quantum dots by using scanning tunnelling microscope (STM)? Explain with necessary diagrams, why does the band gap estimated by STM method differ from the optical method at lower quantum dot sizes? (10)

(b) Estimate the change in potential if an electron is added in a spherical quantum dot of radius 7 nm. (4)

4. (a) Derive an approximate expression for the binding energy of excitons by assuming holes and electrons described by the isotropic masses, m_h and m_e. (7)

(b) Discuss how the energy levels of excitons in quantum wells and other confined systems differ from the energy levels of excitons in bulk semiconductors. (7)

5. (a) Consider a direct band gap semiconductor with interband transitions. Show that the relative strength of optical absorption in quantum dot structure is larger than the other nano structure. (7)



(b) What are deep level and surface defects in nanostructures? Discuss in detail with suitable energy level diagrams, the nature of dangling bonds at the surface of silicon nano-crystallites. (7)

6. (a) What is Coulomb blockade effect? In order to observe Coulomb blockade at room temperature for an Au quantum dot, what is the minimum size and resistance of the Au quantum dot nanostructure? (8)

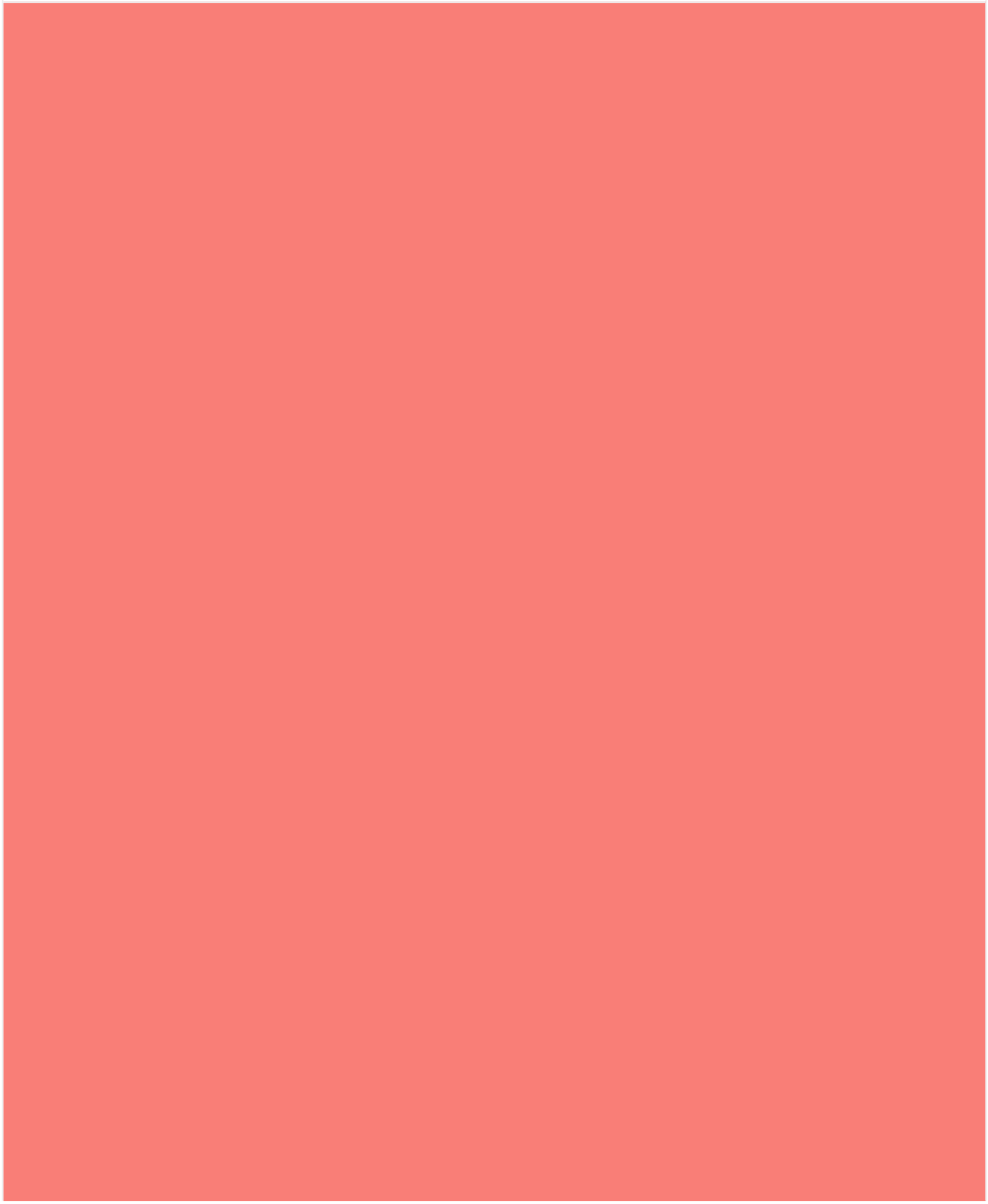
(b) For gold, an fcc metal, calculate the surface energy in terms of joules per atom, of a freshly cleaved [111] plane. In bulk state, the coordination number of gold is 12. (6)

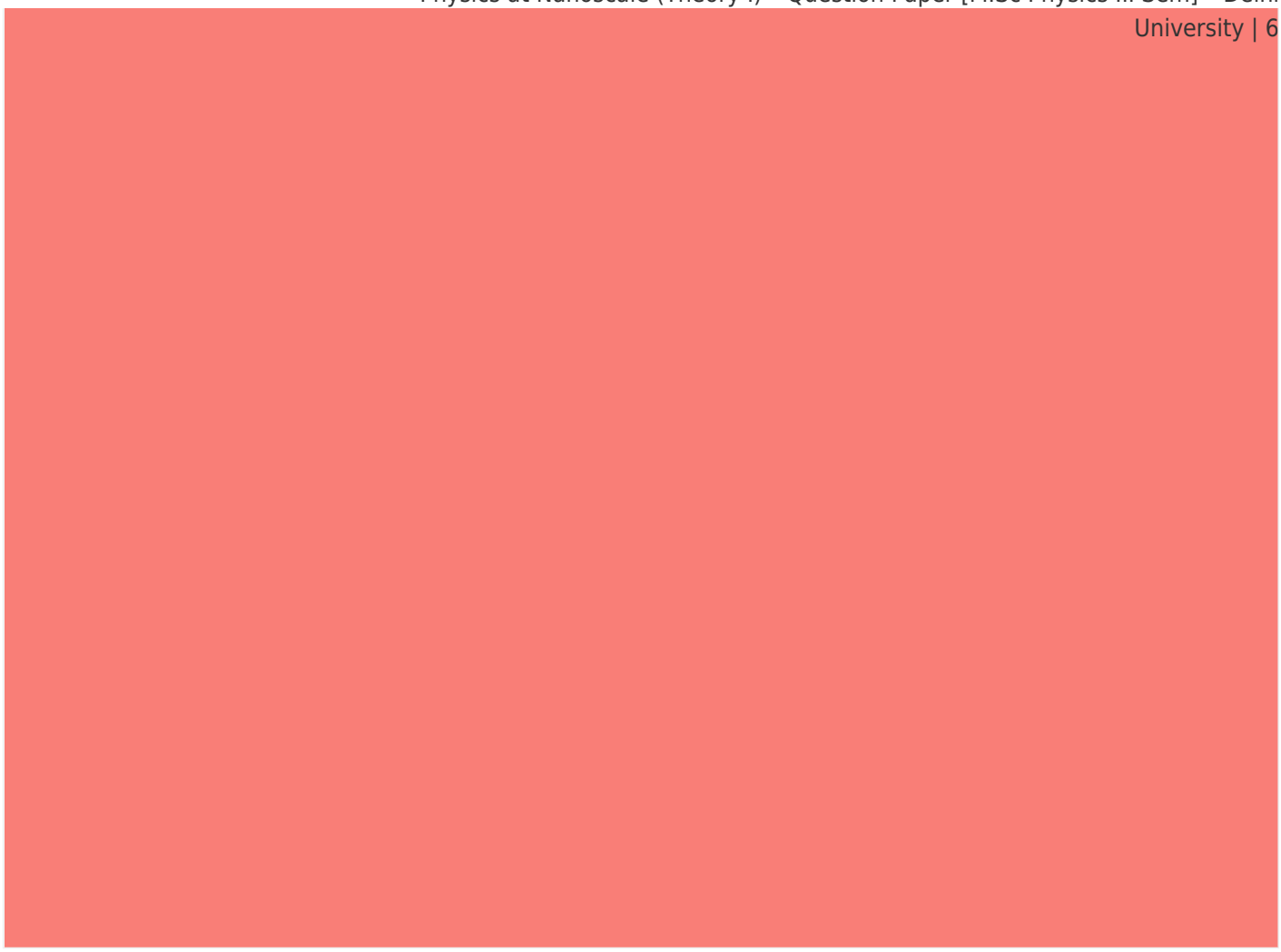
Manas Sharma

I’m a physicist specializing in computational material science with a PhD in Physics from Friedrich-Schiller University Jena, Germany. I write efficient codes for simulating light-matter interactions at

atomic scales. I like to develop Physics, DFT, and Machine Learning related apps and software from time to time. Can code in most of the popular languages. I like to share my knowledge in Physics and applications using this Blog and a YouTube channel.

manas.bragitoff.com/





Share this:

Click to share on Facebook (Opens in new window)

Click to share on Twitter (Opens in new window)

Click to share on WhatsApp (Opens in new window)

Click to share on Pinterest (Opens in new window)

Click to share on Reddit (Opens in new window)

Click to share on LinkedIn (Opens in new window)

Click to email a link to a friend (Opens in new window)

Click to print (Opens in new window)

Click to share on Tumblr (Opens in new window)

Click to share on Pocket (Opens in new window)

Click to share on Telegram (Opens in new window)

[wpedon id="7041" align="center"]