Solid State Physics- Project Titles:

Please select the topics from the below list and send it to me by email. You can prepare the projects in a **two-person group**, so please send your names as well. Once a topic selected by a group, others cannot choose it. You should send the projects in a **single spaced pdf file (5 to 10 pages)** and deadline is **ONE WEEK after the final exam**.

1- Graphene

Graphene, the subject of Noble physics prize in 2010, is a promising material which opens a new gateway in the context of electronics and other applications. What is the band structure of this material and how is it important? Discuss about the in-plane and out of plane conductivity in graphene.

2- 2D Materials beyond graphene

Provide some examples on 2D materials beyond the graphene. Explain about their characteristics and special applications.

3- MXenes

Another emerging 2D materials are MXene family. What is the general structure of these category and how they can be synthesized? How the obtained structure can be confirmed based on techniques like XRD, FTIR and SEM?

4- Dislocation

What is “dislocation” in a crystal and how it can effect on elastic properties of a material and strength of alloys? Additionally, provide some examples and applications.

5- Alloys

In the context of solid-state materials, what is importance of alloys? How the portion of elements effects on the material properties (like resistivity and lattice parameters, etc.)? Also discuss about some applications.

6- Magnetic resonance

What is principal of NMR and how it can help us in studying materials structures? Provide a comparison between NMR, FMR and EPR techniques in terms of principals, technical aspects and final data that can provide.

7- Quantum particles:

Compare plasmons, polaritons and polarons in terms are the interactions they are involved in. What is the meaning and consequence of *Peierls instability* of linear metals?

8- Excitons:

How an exciton forms and how Frenkel excitons differ from Mott-Wannier excitons? What is exciton binding energy and how it is important for materials applications like optoelectronic devices?

9- Hetero-structures

Explain semiconductor heterostructures in terms of their band structures and bend bending. Provide three examples with comprehensive description of their applications in energy and environment-related issues.