DEPARTMENT OF PHYSICS
Indian Institute of Technology Patna
Bihta, Patna – 801103, India

MID-SEMESTER EXAMINATION M.M. 30 DURATION: 24 hours (online)
COVID-19 PANDEMIC TIME (ONLINE EXAM)
COURSE: PH401 (INTRODUCTION TO NANOMATERIALS)
DATE: 20-09–2021

(If you feel the question is wrong, please describe why?)
All questions carry the same mark (5)

1. Why does no engineering below nm scale? What is the meaning of 14nm technology? What are the challenges the industries face to handle the 14nm technology? Can one go beyond 14nm to develop technology (Justify your answer)? Why did Moore's law fail?
2. What will be the thickness of MgF_2 on spectacle glass for appearing it as yellow (λ=5893 A^0)? If an engineer has thermal evaporation and pulse LASER systems for the thin film deposition. Which technique will be better to get a high-quality view (explain and justify your answer). Explain the principle of the pulse laser deposition (PLD)/thermal evaporation system. [Refractive index of MgF_2~1.4 and glass of spectacle~1.5].
3. What is/are the differences between Macro and Micro grains? What is the importance of micro-grain in nanoscience and technology? An engineer prepared two steel rods by two different methods :(i) Ball milled the steel for 72hrs and hot press the obtained granules (obtained powder from the ball mill process), and (ii) melt casting. Which rod will have more strength i.e. hot press or melt casting (explain and justify your answer)?
4. Nowadays the use of permanent magnets (Hexaferrite/NdFeB/alnico) has increased in automobile sectors. Permanent magnets are used as sensors and many more. So, For industrial application one need maximum *(BH)max* and *Hc* (coercivity). Find the decrease of critical diameter NdFeB if an engineer has increased its saturation magnetization from 70 emu/g to 100 emu/g without changing its crystal symmetry and magnetic anisotropy. Suggest a method to make a high-quality thin film of such a permanent magnet and explain its (thin film deposition) process.
5. What is the importance of the surface-to-volume ratio in nanotechnology? What is the magic number in nanoscience for a simple cubic (SC) crystal structure? Derive a formula to generate the magic numbers. Sketch the plot of surface-to-volume ratio versus particle size for SC crystal symmetry.
6. Explain the Lithography (visible/Ultraviolate/X-ray/Electron) method steps. How does it differ from the nanoimprint method? Which method is cost-effective for industrialization? What is/are the advantage/s of electron lithography over nanoimprint.

----------BEST OF LUCK----------