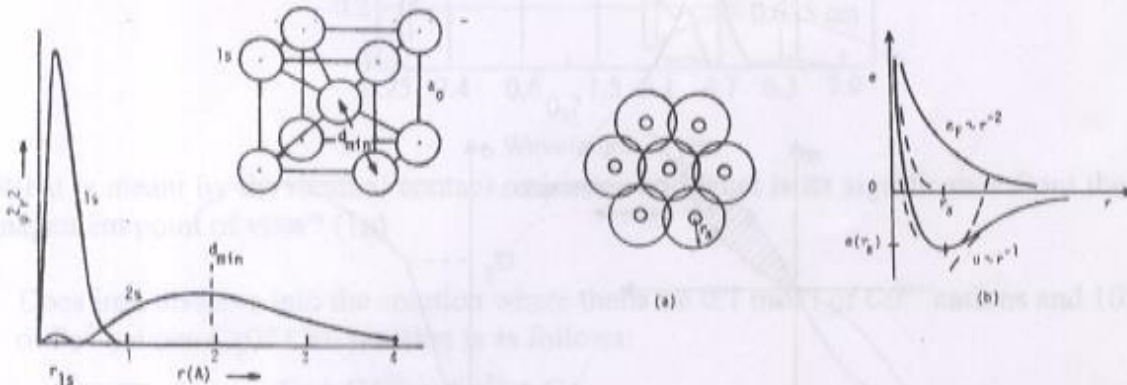
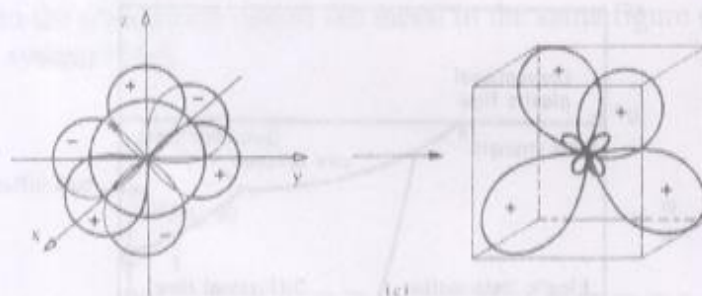


1. a) "Particle inside an infinite potential well" problem gives as one of its result the following dependency between energy and volume $E \propto V^{-\frac{2}{3}}$. Based on this relation what happens to energy levels when you reduce the dimensions of your object to nanolevel (start to confine the movement of electrons)? (1p)



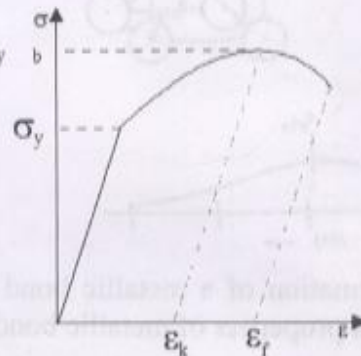
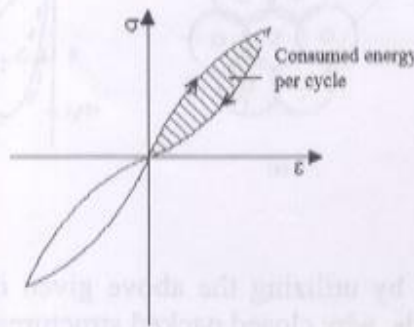
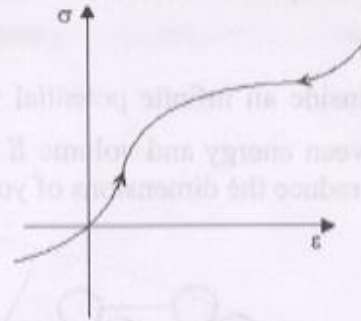
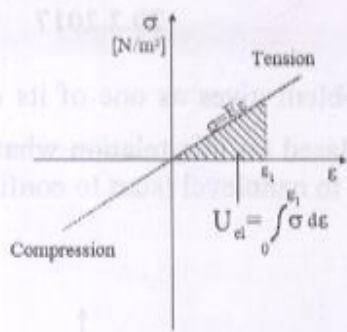
b) Explain the formation of a metallic bond by utilizing the above given diagrams. Explain, by utilizing the typical properties of metallic bonds, why closed packed structures are typical for metals (2 p)

c) Figure below shows the formation of sp^3 hybridized orbitals. Explain briefly what happens during the hybridization and what the "driving" force behind the hybridization is in the first place. (2p)

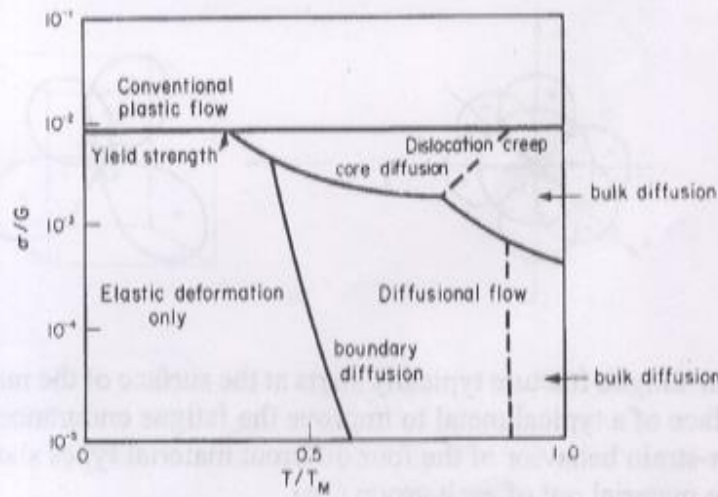


2. a) Explain why the fatigue fracture typically starts at the surface of the material? Give one example how to treat the surface of a typical metal to improve the fatigue endurance (1p)

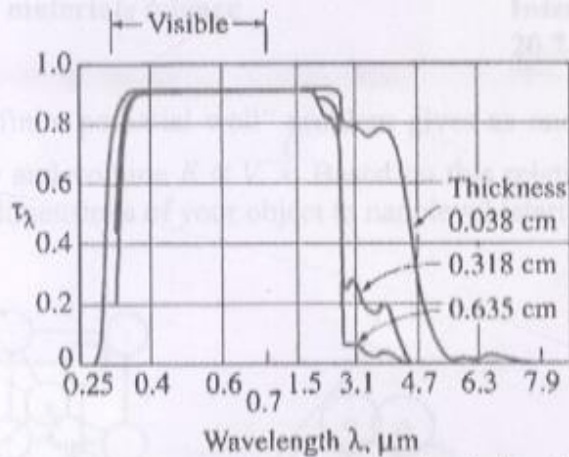
b) Explain the stress-strain behavior of the four different material types shown in the figure below and give an example material out of each group (2p)



c) Use the below deformation diagram to explain the mechanical behavior of the given material under different stress-temperature conditions (2p).



3. a) By which mechanisms heat is conducted in solids, liquids and in gases? (2p)
- b) Use the transmissivity figure for SiO_2 (main component in car windows) below to explain why car when left under direct sunlight acts as a heat trap and gets heated up from the interior? (2p)



c) What is meant by the thermal contact resistance and what is its significance from the thermal management point of view? (1p)

4. a) Does iron dissolve into the solution where there are 0,1 mol/l of Cd^{2+} cations and 10^{-6} mol/l of Fe^{2+} cations (2p)? Cell reaction is as follows:



$$E_{\text{Cd} \rightarrow \text{Cd}^{2+} + 2e^-}^\theta = -0,403\text{V}$$

$$E_{\text{Fe} \rightarrow \text{Fe}^{2+} + 2e^-}^\theta = -0,440\text{V}$$

- b) Use the Evans diagram below to explain the phenomena taking place while the metal in question is dissolved (2p).
- c) What happens to the dissolution rate of the metal in the same figure (and why) if you induce mixing to your system? (1p)

