Reg. No. \_\_\_\_\_\_\_\_\_\_\_\_



**End Semester Examination – Nov/Dec – 2017**

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| **Code :** | **16NT3004** | **Duration :** | **3hrs** |
| **Sub. Name :** | **MAGNETIC NANOMATERIALS AND NANOFLUIDS** | **Max. marks :** | **100** |

**ANSWER ALL QUESTIONS (5 × 20 = 100 Marks)**

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| **Q. No.** | **Sub Div.** | **Questions** | **Course**  **Outcome** | **Marks** |
| 1. | a. | Draw the ground state multiplets of Ho3+ and Yb3+ and determine their ground state J values. | CO1 | 4 |
| b. | Match the following:   |  |  | | --- | --- | | Magnetic field | emu/Oe.g | | Mass susceptibility | dimensionless | | Volume susceptibility | H/m | | Permeability of free space | Oe | | CO2 | 4 |
| c. | Identify from the following magnetization plot which kind of magnetic material the magnetic behavior corresponds to:    Justify your answer in one or two sentences. | CO1 | 4 |
| d. | Illustrate a vector model showing spin-orbit coupling and the resultant total momentum. | CO1 | 4 |
| e. | The magnetic susceptibility of silicon is*−*0.4*×*10−5. Calculate the flux density and magnetic moment per unit volume when magnetic field of intensity 5*×*105A/mis applied. | CO4 | 4 |
| (OR) | | | | |
| 2. | a. | Match the following magnetization curves in the first column with those relevant in the second column. Give justification to the matching (in the space given in the third column).   |  |  |  | | --- | --- | --- | |  | Iron oxide (type I) | Spa | |  | Pristine MoS2 | ZnO | |  | Iron oxide (type II) | S | |  | Nd-Fe-B magnet |  | | CO2 | 4 |
| b. | Explain the phenomenon of ferromagnetism with the key points on its origin. | CO2 | 4 |
| c. | What are meant by i. diamagnetism and ii. Curie temperature? | CO1 | 4 |
| d. | The following are the XRD patterns of iron oxide nanoparticles of two different forms viz., Fe2O3 and Fe3O4. Identify which XRD belongs to which oxide. Match them with the corresponding XPS spectra with justification.   |  |  | | --- | --- | |  |  | | CO2 | 4 |
| e. | The saturation magnetic induction of Nickel is 0.65 Wb m–2. If the density of Nickel is 8906 kg m–3and its atomic weight is 58.7, calculate the magnetic moment of the Nickel atom in Bohr magnetron. | CO4 | 4 |
| 3. | a. | Define easy and hard axes of magnetization. | CO2 | 4 |
| b. | Explain thermal and alternating field demagnetization techniques. | CO1 | 4 |
| c. | In the following three cases of domain walls, belonging to various grain sized samples of magnetite nanoparticles (same chemical composition), will the magnetic moments be the same? Give reasons to your answer. | CO3 | 4 |
|  | d. | Match the following:   |  |  | | --- | --- | | TRM | Magnetization acquired during chemical change in an external magnetic field | | CRM | Magnetization acquired by sediments where grains settle in an external magnetic field | | IRM | Magnetization acquired during cooling from above the Curie temperature in an external field | | DRM | Magnetization acquired instantaneously in an external field | | CO3 | 4 |
| e. | Briefly explain superparamagnetic nanoparticles. | CO1 | 4 |
| (OR) | | | | |
| 4. | a. | Identify the following coercivity profiles as corresponding to each of the nanoparticles given at the right hand side. | CO3 | 4 |
| b. | Describe stress anisotropy and its contribution to magnetism of materials. | CO2 | 4 |
| c. | What are Block wall and Neel wall? | CO2 | 4 |
| d. | Observe the following images of manganese ferrite nanoparticles. Assuming that the width of the nanoparticles is the same in all the three cases, which of these samples will have more anisotropic contribution to magnetism? Justify your answer. | CO2 | 4 |
| e. | Match the following:   |  |  | | --- | --- | | Stress anisotropy | Paramagnetism | |  | Magnetostriction constants | |  | Spin canting | | Goudsmidt and Uhlenbeck | Small exchange energy | |  | S = h/2π | |  | Magnetostatic energy | | Quartz (SiO2) | L = h/2π | | Surface charge distribution | Negative magnetic susceptibility | | CO4 | 4 |
| 5. | a. | The following table lists out the magnetic moments of rare earth ions. The moments theoretically calculated and experimentally determined generally agree well with each other. But there are differences between such values in the case of Sm3+ and Eu3+ ions. Account for this anomalous difference.   |  |  |  | | --- | --- | --- | | Ion | Magnetic moment in Bohr magneton | | | Experimental | Calculated | | Ce3+ | 2.4 | 2.5 | | Pr3+ | 3.5 | 3.6 | | Gd3+ | 8.0 | 7.9 | | Sm3+ | 1.5 | 0.8 | | Eu3+ | 3.4 | 0 | | CO3 | 4 |
| b. | Write the two equations of magnetization which need to be satisfied when Weiss molecular magnetic field is present. Draw a graph showing the simultaneous representation of the magnetization vs. Brillouin function, following the two equations. | CO3 | 4 |
| c. | Compared to the electronic moment, the nuclear magnetic moment does not significantly contribute to the net magnetic moment of a magnetic material. Justify the statement. | CO3 | 4 |
| d. | There cannot be any material to be called as non-magnetic material. Give reasons for the statement. | CO2 | 4 |
| e. | Briefly explain the working of a vibrating sample magnetometer. | CO2 | 4 |
| (OR) | | | | |
| 6. | a. | Elaborate the concept of exchange interactions in magnetic materials and explain how they lead to strong magnetism. | CO3 | 12 |
| b. | Describe the case of exchange interaction in rare earth manganites. | CO3 | 4 |
| c. | Explain magnetocaloric effect in magnetic materials. | CO3 | 4 |
| 7. | a. | Explain magnetic domains in nanoparticles. Elaborate how magnetic domain formation in nanoparticles depends on size. | CO4 | 10 |
| b. | Describe the relationship between super paramagnetism and blocking temperature. | CO1 | 6 |
| c. | The following is a schematic representation of the possible arrangements of clusters of magnetic atoms on the surface of fcc (0 1 1) Ag. Explain how the arrangement affects the magnetic moment. | CO4 | 4 |
| (OR) | | | | |
| 8. | a. | Give a brief account of permanent magnets used in loud-speakers. | CO1 | 4 |
| b. | Choose the best answer: The molecular field concept was hypothesized by ………  i. Schrödinger ii. Uhlenbeck iii. Weiss iv. Von Leeuwen | CO4 | 1 |
| c. | Choose the best answer: The state represented by  is ………  i. Symmetric singlet state ii. Anti-symmetric singlet state iii. Symmetric triplet state iv. Anti-symmetric triplet state | CO4 | 1 |
| d. | Which one of the following is the strongest magnetic material?  i. Fe3O4 ii. Nd2Fe14B iii. AlNiCo iv. Fe3S4 | CO4 | 1 |
| e. | The magnetic state shown in the following figure for a magnetic material of reduced dimension is …….. state.    i. Weiss ii. Curie iii. Landau iv. Kittel | CO4 | 1 |
| f. | Explain the concept of blocking temperature in superparamagnetic materials | CO3 | 6 |
| g. | Match the following:   |  |  | | --- | --- | | Narrow hysteresis loop | Superparamagnetic material | | 50 µm sized SrFe2O4 | Soft ferromagnetic material | | Zero remanence | Diamagnetic material | | Exchange integral in (C–J) | Hard ferromagnetic material | | Silicon dioxide | Spin-orbit coupling only decides magnetism | | Fe2+ ion | Antiferromagnetic material | | CO4 | 6 |
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|  | | **Compulsory:** |  |  |
| 9. | a. | There are three samples of magnetic materials viz., sphere-shaped nanoparticles of size 8 nm, rod shaped nanoparticles of diameter 180 nm, and disc-shaped nanoparticles of size 75 nm. Which sample is the best suited for magnetic-field assisted drug delivery? Justify your answer with suitable reasons. | CO5 | 5 |
| b. | Explain the applications of magnetic nanomaterials in data storage devices. | CO5 | 5 |
| c. | Discuss any one method of preparation of colloidal magnetite nanoparticles. | CO5 | 5 |
| d. | Discuss the applications of magnetic nanofluids in heat dampers. | CO5 | 5 |

ALL THE BEST