PHYE-411 – Generic Electives 4 (D4) : Magnetic Materials and Superfluidity

(Credits: 04; Contact Hours: 60)

Lectures: 48

Tutorials: 12

Learning Objectives:

The objective of the course is to teach types and origins of magnetism in solids. In addition, we will discuss physical reasons that is directly or indirectly related to magnetism. The theories of dia, para, ferro, antiferro, ferri-magnetism and superfluidity will be understood in detail.

Learning Outcomes:

Upon successful completion of the course, students will be able to:

1. Discover the physical origin of diamagnetism in solids.
2. Discover the physical origin of paramagnetism in solids.
3. Group the materials according to their magnetic susceptibilities
4. Analyze the strong magnetization in ferromagnetic materials
5. Determine the differences between ferro and ferrimagnetic substances
6. Compute the experimental results by theoretical calculations.
7. Argue the magnetic dipole, spin and superfluidity concepts in detail

Course Contents:

Unit I: Diamagnetism and Paramagnetism:

Classification of Magnetic Materials, Langevin's theory of diamagnetism, Quantum theory of Diamagnetism of Mononuclear system, Paramagnetism: Origin, Langevin's classical theory of Paramagnetism, Weiss theory, quantum theory of paramagnetism, magnetism of rare earth ions, iron group ions, crystal field splitting, quenching of orbital angular momentum, Hund rules, paramagnetic susceptibility of conduction electrons, Van Vleck Temperature – Independent Paramagnetism, Problems.

Unit II: Ferromagnetism:

Ferromagnetic ordering, Weiss theory, Curie – Weiss law, Heisenberg exchange interaction, magnon and dispersion relation for magnons, Quantization of spin waves, Thermal excitation of Magnons, origin of domains, domain walls, coercive force, hysteresis, motion of domain walls, experimental methods to determine the magnetic susceptibility, thickness and energy of Bloch wall, anisotropy energy, Problems.

Unit III: Antiferromagnetism and Ferrimagnetism:

Antiferromagnetc order, the two sublattice model, susceptibility below the Neel temperature, the dispersion relation for magnons in an antiferromagnet, super exchange interaction,

Ferrimagnetic order, Curie temperature and susceptibility of ferrimagnets, Spinel, Garnets, ferrimagnetic compounds, properties of ferromagnetic substances: High Temperature Susceptibilities, Specific Heat, Thermal Conductivity, the structure of ferrites, the saturation magnetization, Neel's theory.

Unit IV: Superfluidity:

Phenomenology, two fluid model, Bose-Einstein Condensation, Landau theory, super fluid viscocity, super fluid flow, excited state, Ginzberg- Landau equations, second order critical fields, Abrikosov vortex lattices.

References:

1. Introduction to Solid State Physics, Charles Kittel, Willey Eastern Pvt. Ltd. Seventh Edition -2009.
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11. Introduction to Magnetic Materials- B. D. Cullity and C. D. Graham, Second Edition, Willey Online Library, Published Online: 29 FEB 2008 DOI: 10.1002/9780470386323, e-Book.
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16. Ferromagnetic ordering in $NpAl_2$: Magnetic susceptibility and ^{27}Al nuclear magnetic resonance, L. Martel, , J.-C. Griveau, R. Eloirdi, C. Selfslag, E. Colineau, R. Caciuffo, Journal of Magnetism and Magnetic Materials, Volume 387, 1 August 2015, Pages 72–76.
17. Carbon-Induced Ferromagnetism in the Antiferromagnetic Metallic Host Material Mn_3ZnN

Ying Sun *†, Yanfeng Guo ‡, Yoshihiro Tsujimoto †, Jiajia Yang §, Bin Shen §, Wei Yi Yoshitaka Matsushita ‖, Cong Wang ⊥, Xia Wang ‡, Jun Li ‡, Clastin I. Sathish ‡⊗, and Kazunari Yamaura *‡*Inorg. Chem.*, 2013, 52 (2), pp 800–806, **DOI:** 10.1021/ic3019265 Publication Date (Web): January 7, 2013.

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PHYE-412 – Electives 5 (A5/ B5/ C5/ D5)

PHYE-412 – Electives 5 (A5) : 8051- Microcontroller

(Credits: 04; Contact Hours: 60)

Lectures: 48

Tutorials: 12

Learning objectives:

- Give an understanding about the concepts and basic architecture of 8051
- Provide an overview of difference between microprocessor and micro controller
- Provide background knowledge and core expertise in 8 bit microcontroller 8051.
- Study the architecture, various blocks from 8051 , ports, memory organization and various addressing modes of 8051 and various moving op-code.
- Give knowledge about arithmetic operations and jump ranges and instructions.
- Impart knowledge about assembly language programs of 8051
- Help understand the importance of different peripheral devices & their interfacing to 8051
- Impart knowledge of different types of external interfaces including LEDS, LCD, Keypad Matrix, Stepper motor & seven segment displays.

Learning Outcomes :

- The students would learn the basic difference between the microprocessors and microcontroller with the family information.
- The students will learn the architecture and basic function of the microcontroller.
- The students will learn the programming tools which is used for the programming of the microcontroller.
- The students will learn the 8051 microcontroller assembly language program logic. The students will learn hardware interface of the microcontroller with the actual devices like stepper motor, LCD etc.

Course contents:

Unit I: 8051 Microcontroller:

An Introduction: Microprocessors and Microcontrollers, comparing microprocessors and Microcontrollers, a Microcontrollers survey, development system for Microcontrollers, 8051 Microcontroller hardware: Block diagram, Programming model, pin diagram, the 8051 oscillator and clock, program counter and data pointer, A and B CPU registers, flags and program status word, internal memory, internal RAM, the stack and the stack pointer, special function registers, internal ROM; Input / output pins, ports and circuits: port pin circuits, port 0, port 1, port 2, port 3; external memory, counters and timers, serial data input / outputs, interrupts.

Unit II: Moving data and logical operations:

Move Operations: Introduction, addressing modes, external data moves, code memory read only data moves, push and pop op-codes, data exchange, simple programs, Logical

operations: Introduction, byte level logical operations, bit level logical operation, rotate and swap operations, examples programs.

Unit III: Arithmetic Operations:

Introduction, flags, instructions affecting flags, incrementing and decrementing, addition: unsigned and signed , multiple byte signed arithmetic, subtraction : Unsigned and signed subtraction, multiplication and division, decimal arithmetic, examples programs;

Unit IV: Jump and call Instructions and applications:

Introduction, the jump and call program range, relative range, Short absolute range, long absolute range. Jumps, bit jumps, byte jumps, unconditional jumps, Calls and subroutine, subroutines, Calls and the stacks, Calls and returns. Interrupts and returns, examples problems. Application of 8051 Microcontroller: Simple programmes using 8051 Microcontroller, Display, generation of waves, Pulse measurements, D/A and A/D conversion, Stepper motor.

References:

1. The 8051 Micorcontroller, Architecture, Programming and applications by Kenneth J Ayala ; Second Edition, ISBN 0-314—20188-2 (hard Copy) 1991; ISBN 0-314-77278-2(Soft) 2014.
2. Microprocessors and Interfacing : Programming and Hardware by Douglas V Hall : II Edition ; Tata McGraw-Hill Edition
3. The 8051 Microcontroller and embedded Systems by Muhammad Ali Mazidi and Janice Gillspie Mazidi; Pearson Education.

PHYE-412 – Electives 5 (B5) : Lasers, Nonlinear Optical mixing and Spectroscopic Phenomena

(Credits: 04; Contact Hours: 60)

Lectures: 48

Tutorials: 12

Learning Objectives:

To enable the students to study the basic and advance concepts of Lasers, non-linear optical mixing and spectroscopic phenomena.

Learning Outcomes:

Students will be able to study the basic and advance concepts of Lasers, non-linear optical mixing and spectroscopic phenomena.

Course Contents:

Unit I: Basic Concepts:

Absorption, induced and spontaneous emission, Polarization of light, absorption and emission spectra, transition probabilities, life times, spontaneous and radiationless transitions, Semiclassical description, Basic equations. Dipole approximation, Coherence properties of radiation fields, temporal, spatial coherence, coherence volume, the coherence function and the degree of coherence

Unit II: Lasers:

Fundamentals, basic elements, threshold condition, rate equations, laser resonators, open optical resonator, stability of resonators. Spectral characteristics of laser emission, active resonators and laser modes, gain saturation, spatial hole burning. Multimode lasers and gain competition, mode pulling

Unit III: Tunable lasers:

Basic concepts, semiconductor-diode laser, Tunable solid state lasers, color center lasers, Dye lasers: flash lamp pumped dye lasers, Pulsed-laser pumped dye laser, continuous wave dye laser

Unit IV: Non liner optical mixing:

Physical Background , Phase Matching, Second harmonic generation, Quasi Phase Matching Sum frequency & higher harmonic generation. X ray laser. Optical parametric oscillator, Difference-Frequency Spectrometer [Scope: Reference 1, chapter 5:5.8]

References:

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