MANONMANIAM SUNDARANAR UNIVERISTY,
TIRUNELVELI-12

# SYLLABUS

## PG - COURSES – AFFILIATED COLLEGES

Course Structure for M. Sc. Physics
(Choice Based Credit System)
(with effect from the academic year 2024-2025 onwards )

| Semester-II | | | | |
|---|---|---|---|---|
| **Part** | **Subject Status** | **Subject Title** | **Subject Code** | **Credit** |
| 3 | Core | STATISTICAL MECHANICS | VPHC21 | 5 |
| 3 | Core | QUANTUM MECHANICS - I | VPHC22 | 5 |
| 3 | PRACTICAL II | PRACTICAL – II GENERAL PHYSICS AND ELECTRONICS EXPERIMENTS – II | VPHL21 | 4 |
| 3 | DISCIPLINE CENTRIC ELECTIVE- II | ADVANCED OPTICS/ NON LINEAR DYNAMICS/ PHYSICS OF NANO SCIENCE AND TECHNOLOGY | VPHE21/ VPHE22/ VPHE23 | 3 |
| 3 | GENERIC ELECTIVE -II | MICROPROCESSOR 8085 AND MICROCONTROLLER 8051/ MATERIAL SCIENCE/ CHARACTERIZATION OF MATERIALS | VPHE24/ VPHE25/ VPHE26 | 3 |
| 3 | SEC I | PHYSICS FOR COMPETITIVE EXAMINATIONS | VPHSE21 | 2 |

**Total Marks: 100 Internal Exam: 25 marks + External Exam: 75 marks**

A. **Scheme for internal Assessment**:
Maximum marks for written test: **15 marks**
**3 internal tests**, each of **I hour** duration shall be conducted every semester.
To the average of the **best two** written examinations must be added the marks scored in. The **assignment** for 5 marks and Seminar for 5 marks

The break up for internal assessment shall be:
Written test- 15 marks; Assignment -5 marks; Seminar-5 Marks Total - 25 marks

**B. Scheme of External Examination**
**3 hrs.** examination at the end of the semester
A – Part : 1 mark question two - from each unit
B – Part : 5 marks question one - from each unit
C – Part : 8 marks question one - from each unit

## ➢ Conversion of Marks into Grade Points and Letter Grades

| S.No. | Percentage of Marks | Letter Grade | Grade Point | Performance |
|---|---|---|---|---|
| 1 | 90 - 100 | O+ | 10 | Outstanding |
| 2 | 80 - 89 | O | 9 | Excellent |
| 3 | 70 - 79 | A+ | 8 | Very Good |
| 4 | 60 - 69 | A | 7 | Good |
| 5 | 55 - 59 | B+ | 6 | Above Average |
| 6 | 50 - 54 | B | 5 | Pass |
| 7 | 0 - 49 | RA | - | ReAppear |
| 8 | Absent | AA | - | Absent |

## ➢ Cumulative Grade Point Average (CGPA)

$$\mathbf{CGPA} = \frac{\mathbf{\Sigma\,(GP \times C)}}{\mathbf{\Sigma C}}$$

- **GP** = Grade point, **C** = Credit
- CGPA is calculated only for Part-III courses
- CGPA for a semester is awarded on cumulative basis

## ➢ Classification

a) First Class with Distinction : CGPA $\geq$ 7.5*****
b) First Class : CGPA $\geq$ 6.0
c) Second Class : CGPA $\geq$ 5.0 and $<$ 6.0
d) Third Class : CGPA $<$ 5.0

# STATISTICAL MECHANICS

**Learning Objectives**

- To acquire the knowledge of thermodynamic potentials and to understand phase transition in thermodynamics
- To identify the relationship between statistic and thermodynamic quantities
- To comprehend the concept of partition function, canonical and grand canonical ensembles
- To grasp the fundamental knowledge about the three types of statistics
- To get in depth knowledge about phase transitions and fluctuation of thermodynamic properties that vary with time

**UNIT I**

**THERMODYNAMICS AND PHASE TRANSITIONS**

Thermodynamic potentials and the reciprocity relations - Thermodynamic Equilibrium - Gibb's phase rule - Third law of Thermodynamics - Phase transitions of first and second kind – Critical exponent - Phase Transitions of the second kind: The Ising model – Bragg-Williams approximation - One dimensional Ising model.

**UNIT II**

**STATISTICAL MECHANICS**

Introduction to statistical mechanics - Phase space – Ensembles and their types – Liouville's theorem – Postulate of equal priori probability – Microstates and macrostates – Stirling's formula – The most probable distribution – Law of equipartition of energy - Entropy and probability – Probability distribution and entropy of a two level system - Negative temperature.

**UNIT III**

**MICRO CANONICAL AND GRAND CANONICAL ENSEMBLES**

Microcanonical ensemble (Isolated system) – Perfect gas in Microcanonical ensemble – Gibbs paradox – Partition function and its correlation with thermodynamic quantities - Grand canonical ensemble (system with an infinite number of particles) – Partition function and thermodynamic functions for Grand canonical ensemble – Perfect gas in Grand canonical ensemble – Applications: Mean kinetic energy of a molecule in a gas, Brownian motion and Harmonic oscillator.

**UNIT IV**

**CLASSICAL AND QUANTUM STATISTICS**

Density matrix - Density matrix in micro canonical, canonical and grand canonical ensembles - Bose-Einstein statistics - Maxwell-Boltzmann statistics - Fermi-Dirac statistics – Black-body radiation and the –Plank radiation law - Bose-Einstein gas - Bose-Einstein condensation – Fermi-Dirac gas.

**UNIT V**

**LOW TEMPERATURE, ISINGMODELAND FLUCTUATIONS**

Production of Low Temperature – Measurement of Low temperature – Approach to absolute zero by adiabatic demagnetization : Principle, Method, Theory and T-S diagram – Conversion of magnetic temperature to Kelvin temperature - Fluctuations and transport phenomena – Brownian movement –Motion due to fluctuating force: The Fokker - Planck equation – Fluctuation in energy and pressure

**TEXT BOOKS**


1. Dr. S. L. Gupta and Dr. V. Kumar, 2008, ElementaryStatistical Mechanics, 22nd Edition, PragatiPrakashan, Meerut.
2. S. K. Sinha, 1990, Statistical Mechanics, Tata McGraw Hill, New Delhi.
3. B. K. Agarwal and M. Eisner, 1998, Statistical Mechanics, Second Edition New Age International, New Delhi.
4. J. K. Bhattacharjee, 1996, Statistical Mechanics: An Introductory Text, Allied Publication, New Delhi.
5. F. Reif, 1965, Fundamentals of Statistical and Thermal Physics, McGraw -Hill, New York.
6. M. K. Zemansky, 1968, Heat and Thermodynamics, 5th edition, McGraw- Hill New York.


**REFERENCE BOOKS**


1. R. K. Pathria, 1996, Statistical Mechanics, 2nd edition, Butter WorthHeinemann, New Delhi.
2. L. D. Landau and E. M. Lifshitz, 1969, Statistical Physics, Pergamon Press, Oxford.
3. K. Huang, 2002, Statistical Mechanics, Taylor and Francis, London
4. W. Greiner, L. NeiseandH.Stoecker, Thermodynamics and Statistical Mechanics, Springer Verlang, New York.
5. A. B. Gupta, H. Roy, 2002, Thermal Physics, Books and Allied, Kolkata.


**WEB SOURCES**

1. https://byjus.com/chemistry/third-law-of-thermodynamics/
2. https://web.stanford.edu/~peastman/statmech/thermodynamics.html
3. https://en.wikiversity.org/wiki/Statistical_mechanics_and_thermodynamics
4. https://en.wikipedia.org/wiki/Grand_canonical_ensemble
5. https://en.wikipedia.org/wiki/Ising_model

# QUANTUM MECHANICS

**Learning Objectives**

- To develop the physical principles and the mathematical background important to quantum mechanical descriptions.
- To describe the propagation of a particle in a simple, one-dimensional potential.
- To formulate and solve the Schrodinger's equation to obtain eigenvectors and energies for particle in a three-dimensional potential.
- To explain the mathematical formalism and the significance of constants of motion, and see their relation to fundamental symmetries in nature
- To discuss the Approximation methods like perturbation theory, Variational and WKB methods for solving the Schrödinger equation.

**UNIT I**

**BASIC FORMALISM**

Wave Mechanical Concepts: Wave packet - Time dependent Schrodinger equation – Interpretation of the wave function –Ehrenfest's theorem- Time independent Schrodinger equation - Stationary states — Linear vector space – Linear operator – Eigen functions and Eigen Values – Hermitian Operator – Postulates of Quantum Mechanics – Simultaneous measurability of observables – General Uncertainty relation.

**UNIT II**

**GENERAL FORMALISM**

Dirac notation – Equations of motions – Schrodinger representation –Heisenberg representation – Interaction representation –Momentum representation – Symmetries and conservation laws: Conservation of linear momentum, Energy and Angular momentum – Parity conservation and time reversal.

**UNIT III**

**ONE DIMENSIONAL AND THREEDIMENSIONAL ENERGY EIGEN VALUE PROBLEMS**

Square – well potential with rigid walls – Square well potential with finite walls – Square potential barrier – Alpha emission – Bloch waves in a periodic potential – Kronig-Penny square – well periodic potential – Linear harmonic oscillator: Operator method – Particle moving in a spherically symmetric potential – System of two interacting particles –Rigid rotator– Hydrogen atom.

**UNIT IV**

**APPROXIMATION METHODS**

Time independent perturbation theory: Non-degenerate energy levels – Ground state of Helium atom – First order Stark effect in Hydrogen atom – Degenerate

energy levels - Excited state of Hydrogen atom – WKB approximation – Connection formulae (no derivation) –Application of WKB method: Barrier penetration – Alpha emission.

**UNIT V**

**ANGULAR MOMENTUM**

The Eigenvalue spectrum– Ladder operators– Matrix representation of J – Spin angular momentum – Addition of angular momenta – CG Coefficients – Angular momentum commutation relations – Eigen values of J2 and Jz - Spin angular momentum - Pauli's exclusion principle.

**TEXT BOOKS**


1. P.M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics, 2ndedition (37th Reprint), Tata McGraw-Hill, New Delhi, 2010.
2. G.Aruldhas, Quantum Mechanics, 2nd edition, Prentice Hall of India, New Delhi, 2009.
3. David J Griffiths, Introduction to Quantum Mechanics. 4th edition, Pearson, 2011.
4. SL Gupta and ID Gupta, Advanced Quantum Theory and Fields, 1st Edition, S.Chand& Co., New Delhi, 1982.
5. A.Ghatak and S. Lokanathan, Quantum Mechanics: Theory andApplications, 4th Edition, Macmillan, India, 1984.


**REFERENCE BOOKS**


1. E.Merzbacher, Quantum Mechanics, 2nd Edition, John Wiley and Sons, New York, 1970.
2. V.K. Thankappan, Quantum Mechanics, 2nd Edition, Wiley Eastern Ltd, New Delhi, 1985.
3. L.D. Landau and E. M. Lifshitz, Quantum Mechanics, 1st edition, Pergomon Press, Oxford, 1976.
4. S.N. Biswas, Quantum Mechanics, Books and Allied Ltd., Kolkata,1999.
5. V.Devanathan, Quantum Mechanics, 2nd edition, Alpha Science International Ltd, Oxford , 2011.


**WEB SOURCES**

1. http://research.chem.psu.edu/lxjgroup/download_files/chem565-c7.pdf
2. http://www.feynmanlectures.caltech.edu/III_20.html
3. http://web.mit.edu/8.05/handouts/jaffe1.pdf
4. https://hepwww.pp.rl.ac.uk/users/haywood/Group_Theory_Lectures/Lecture_1.pdf
5. https://theory.physics.manchester.ac.uk/~xian/qm/chapter3.pdf

# PRACTICAL II - GENERAL PHYSICS AND ELECTRONICS EXPERIMENTS – II

**Learning Objectives**

- To understand the concept of mechanical behavior of materials and calculation of same using appropriate equations.
- To calculate the thermodynamic quantities and physical properties of materials.
- To analyze the optical and electrical properties of materials.
- To observe the applications of FET and UJT.
- To study the different applications of operational amplifier circuits.
- To learn about Combinational Logic Circuits and Sequential Logic Circuits

**PRACTICAL I**

(Choose any SIX experiments from Part A and SIX from Part B)

**PART A General Physics Experiments -II**

1. Determination of Young's modulus and Poisson's ratio by Elliptical fringes - Cornu's Method
2. Study the beam divergence, spot size and intensity profile of Diode/He-Ne laser.
3. B-H curve - Formation and tracing magnetic hysteresis loop and determination of energy loss for the given specimen.
4. Measurement of Magnetic Susceptibility by Guoy's method
5. Formation of acoustic grating in a given liquid and determination of velocity of ultrasonic wave in the liquid and compressibility of liquid. (Ultrasonic diffraction)
6. Determination of Thickness of thin film using Michelson Interferometer
7. Determination of Refractive index of liquids using diode Laser/ He – Ne Laser
8. Determination of Numerical Apertures and Acceptance angle, attenuation of optical fibers
9. Equipotential lines and electric field mapping for electrodes of different shapes.
10. Determination of Mutual Inductance and coefficient of coupling for the given pair of coils using Heaviside Bridge method
11. Hall Effect – determination of Hall coefficient, carrier concentration and mobility
12. Temperature coefficient of a thermistor using Carry Foster Bridge.

**PART B Electronics Experiments -II**

1. Determination of V-I Characteristics and efficiency of solar cell.
2. Construction of a relaxation oscillator using UJT, measuring the frequency of oscillation for different RC values and comparing it with the theoretical value.

3. Modulus counter using IC 7490 and seven segment display using IC 7447 / IC 7448
4. Solving simultaneous equations using IC 741 / IC LM324
5. Study of Op-Amp –Active filters: Low pass, High pass and Band pass filters
6. Construction of Current to Voltage and Voltage to Current Convertor using IC 741
7. Construction of square wave generator using IC 555 and VCO using 555
8. Code Conversion: BCD to Excess- 3 and Excess 3 to BCD
   Binary to Gray and Gray to Binary
9. Study of Binary Ripple Counter using IC 74393 and LEDs
10. Study of RS, Clocked RS and D Flip-Flops.
11. Construction of Shift register and Ring counter using IC 7476 /IC 7474
12. Construction of Schmitt trigger circuit using IC555 for a given hysteresis – Application as squarer

**TEXT BOOKS**

1. Practical Physics, Gupta and Kumar, Pragati Prakasan
2. Kit Developed for doing experiments in Physics- Instruction manual, R.Srinivasan K.R Priolkar, Indian Academy of Sciences
3. Op-Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition.
4. Electronic lab manual Vol I, K ANavas, Rajath Publishing
5. Electronic lab manual Vol II, K ANavas, PHI eastern Economy Edition

**REFERENCE BOOKS**

1. An advanced course in Practical Physics, D.Chattopadhayay, C.R Rakshit, New Central Book Agency Pvt. Ltd
2. Advanced Practical Physics, S.P Singh, PragatiPrakasan
3. A course on experiment with He-Ne Laser, R.S. Sirohi, John Wiley & Sons (Asia) Pvt.ltd
4. Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing
5. Electronic Laboratory Primer a design approach, S. Poornachandra, B.Sasikala, Wheeler Publishing, New Delhi

# ADVANCED OPTICS

**Learning Objectives**

- To know the concepts behind polarization and could pursue research work on application aspects of laser
- To impart an extensive understanding of fiber and non-linear optics
- To study the working of different types of LASERS
- To differentiate first and second harmonic generation
- Learn the principles of magneto-optic and electro-optic effects and its applications

**UNIT 1**

**POLARIZATION AND DOUBLE REFRACTION**

Classification of polarization – Transverse character of light waves – Polarizer and analyzer – Malu's law – Production of polarized light – Wire grid polarizer and the polaroid – Polarization by reflection – Polarization by double refraction – Polarization by scattering – The phenomenon of double refraction – Normal and oblique incidence – Interference of polarized light: Quarter and half wave plates – Analysis of polarized light – Optical activity

**UNIT II**

**LASERS**

Basic principles – Spontaneous and stimulated emissions – Components of the laser – Resonator and lasing action – Types of lasers and its applications – Solid state lasers – Ruby laser – Nd:YAG laser – gas lasers – He-Ne laser – CO2 laser – Chemical lasers – HCl laser – Semiconductor laser

**UNIT III**

**FIBER OPTICS**

Introduction – Total internal reflection – The optical fiber – Glass fibers – The coherent bundle – The numerical aperture – Attenuation in optical fibers – Single and multi-mode fibers – Pulse dispersion in multimode optical fibers – Ray dispersion in multimode step index fibers – Parabolicindex fibers – Fiber-optic sensors: precision displacement sensor – Precision vibration sensor

**UNIT IV**

**NON-LINEAR OPTICS**

Basic principles – Harmonic generation – Second harmonic generation – Phase matching – Third harmonic generation – Optical mixing – Parametric generation of light – Self-focusing of light

**UNIT V**

**MAGNETO-OPTICS AND ELECTRO-OPTICS**

Magneto-optical effects – Zeeman effect – Inverse Zeeman effect – Faraday effect – Voigt effect – Cotton-mouton effect – Kerr magneto optic effect – Electro-optical effects – Stark effect – Inverse stark effect – Electric double refraction – Kerr electro-optic effect – Pockels electro optic effect

**TEXT BOOKS**

1. B.B. Laud, 2017, Lasers and Non – Linear Optics, 3rd Edition, New Age International (P) Ltd.

2. AjoyGhatak, 2017, Optics, 6th Edition, McGraw – Hill Education Pvt. Ltd.
3. William T. Silfvast, 1996, Laser Fundamentals Cambridge University Press, New York
4. J.Peatros, Physics of Light and Optics, a good (and free!) electronic book
5. B.Saleh, and M. Teich, Fundamentals of Photonics, Wiley- Interscience,

**REFERENCE BOOKS**

1. F.S. Jenkins and H. E. White, 1981, Fundamentals of Optics, (4th Edition), McGraw – Hill International Edition.
2. Dieter Meschede, 2004, Optics, Light and Lasers, Wiley – VCH, Varley GmbH.
3. Lipson, S. G. Lipson and H. Lipson, 2011, Optical Physics, 4th Edition, Cambridge University Press, New Delhi, 2011.
4. Y.B. Band, Light and Matter, Wiley and Sons (2006)
5. R.Guenther, Modern Optics, Wiley and Sons (1990)

**WEB SOURCES**

1. https://www.youtube.com/watch?v=WgzynezPiyc
2. https://www.youtube.com/watch?v=ShQWwobpW60
3. https://www.ukessays.com/essays/physics/fiber–optics–and–itapplications.php
4. https://www.youtube.com/watch?v=0kEvr4DKGRI
5. http://optics.byu.edu/textbook.aspx

# NON LINEAR DYNAMICS

**Learning Objectives**

- To school the students about the analytical and numerical techniques of nonlinear dynamics.
- To make the students understand the concepts of various coherent structures.
- To train the students on bifurcations and onset of chaos.
- To educate the students about the theory of chaos and its characterization.
- To make the students aware of the applications of solitons, chaos and fractals.

**UNIT I**

**GENERAL**

Linear waves-ordinary differential equations(ODEs)-Partial differential equations(PDEs)- Methods to solve ODEs and PDEs.- Numerical methods – Linear and Nonlinear oscillators-Nonlinear waves-Qualitative features

**UNIT II**

**COHERENT STRUCTURES**

Linear and Nonlinear dispersive waves - Solitons – KdB equation – Basic theory of KdB equation –Ubiquitous soliton equations – AKNS Method, Backlund transformation, Hirotabilinearization method, Painleve analysis - Perturbation methods- Solitons in Optical fibres - Applications.

**UNIT III**

**BIFURCATIONS AND ONSET OF CHAOS**

One dimensional flows – Two dimensional flows – Phase plane – Limit cycles – Simple bifurcations – Discrete Dinamical system – Strange attractors – Routes to chaos.

**UNIT IV**

**FRACTALS**

Self-similarity - Properties and examples of fractals - Fractal dimension - Construction and properties of some fractals - Middle one third cantor set - Koch curve - Sierpinski triangle – Julia set – Mandelbrot set - Applications of fractals.

**UNIT V**

**APPLICATIONS**

Soliton based communication systems – Solition based computation – Synchronization of chaos – Chaos based communication – Cryptography – Image processing – Stochastic – Resonance – Chaos based computation – Time Series analysis.

**TEXT BOOKS**

1. M.Lakshmanan and S.Rajasekar, Nonlinear Dynamics: Integrability, Chaos and Patterns.Springer, 2003.
2. A.Hasegawa and Y.Kodama, Solitons in Optical Communications. Oxford Press, 1995.
3. Drazin, P. G. Nonlinear Systems. Cambridge University Press, 2012. ISBN: 9781139172455.
4. Wiggins, S. Introduction to Applied Nonlinear Dynamical Systems and Chaos. Springer, 2003. ISBN: 9780387001777.
5. Strogatz, Steven H. Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. Westview Press, 2014. ISBN: 9780813349107.

**REFERENCE BOOKS**

1. G.Drazin and R.S.Johnson. Solitons: An Introduction. Cambridge University Press, 1989.
2. M.Lakshmanan and K.Murali. Chaos in Nonlinear Oscillators. World Scientific, 1989.
3. S.Strogatz. Nonlinear Dynamics and Chaos. Addison Wesley, 1995.
4. Hao Bai-Lin, Chaos (World Scientidic, Singapore, 1984).
5. Kahn, P. B., Mathematical Methods for Scientists & Engineers (Wiley, NY, 1990)

**WEB SOURCES**

1. https://www.digimat.in/nptel/courses/video/108106135/L06.html
2. http://digimat.in/nptel/courses/video/115105124/L01.html
3. https://www.digimat.in/nptel/courses/video/108106135

# PHYSICS OF NANO SCIENCE AND TECHNOLOGY

**Learning Objectives**

- Physics of Nanoscience and Technology is concerned with the study, creation, manipulation and applications at nanometer scale.
- To provide the basic knowledge about nanoscience and technology.
- To learn the structures and properties of nanomaterials.
- To acquire the knowledge about synthesis methods and characterization techniques and its applications.

**UNIT I**

**FUNDAMENTALS OF NANOSCIENCE AND TECHNOLOGY**

Fundamentals of NANO – Historical Perspective on Nanomaterial and Nanotechnology -– Classification of Nanomaterials – Metal and Semiconductor Nanomaterials - 2D, 1D, 0D nanostructured materials - Quantum dots – Quantum wires – Quantum wells - Surface effects of nanomaterials.

**UNIT II**

**PROPERTIES OF NANOMATERIALS**

Physical properties of Nanomaterials: Melting points, specific heat capacity, and lattice constant - Mechanical behavior: Elastic properties – strength - ductility - superplastic behavior - Optical properties: - Surface Plasmon Resonance – Quantum size effects - Electrical properties - Conductivity, Ferroelectrics and dielectrics - Magnetic properties – super para magnetism – Diluted magnetic semiconductor (DMS).

**UNIT III**

**SYNTHESIS AND FABRICATION**

Physical vapour deposition - Chemical vapour deposition - sol-gel – Wet deposition techniques - electrochemical deposition method – Plasma arching - Electrospinning method - ball milling technique - pulsed laser deposition - Nanolithography: photolithography – Nanomanipulator.

**UNIT IV**

**CHARACTERIZATION TECHNIQUES**

Powder X-ray diffraction – X-ray photoelectron spectroscopy (XPS) - UV-visible spectroscopy – Photoluminescence - Scanning electron microscopy (SEM) - Transmission electron microscopy (TEM) - Scanning probe microscopy (SPM) - Scanning tunneling microscopy (STM) – Vibrating sample Magnetometer.

**UNIT V**

**APPLICATIONS OF NANOMATERIALS**

Sensors: Nanosensors based on optical and physical properties - Electrochemical

sensors – Nano-biosensors. Nano Electronics: Nanobots - display screens - GMR read/write heads - Carbon Nanotube Emitters – Photocatalytic application: Air purification, water purification -Medicine: Imaging of cancer cells – biological tags - drug delivery - photodynamic therapy - Energy: fuel cells - rechargeable batteries - supercapacitors - photovoltaics.

**TEXT BOOKS**

1. A textbook of Nanoscience and Nanotechnology, Pradeep T., Tata McGraw-Hill Publishing Co. (2012).
2. Principles of Nanoscience and Nanotechnology, M.A. Shah, Tokeer Ahmad, Narosa Publishing House Pvt Ltd., (2010).
3. Introduction to Nanoscience and Nanotechnology, K. K. Chattopadhyay and A.N. Banerjee, PHI Learning Pvt. Ltd., New Delhi, (2012).
4. Nanostructured Materials and Nanotechnology, Hari Singh Nalwa, Academic Press, (2002).
5. Nanotechnology and Nanoelectronics, D.P. Kothari, V.Velmurugan and Rajit Ram Singh, Narosa Publishing House Pvt.Ltd, New Delhi. (2018)

**REFERENCE BOOKS**

1. Nanostructures and Nanomaterials – HuozhongGao – Imperial College Press (2004).
2. Richard Booker and Earl Boysen, (2005) Nanotechnology, Wiley Publishing Inc. USA
3. Nano particles and Nano structured films; Preparation, Characterization and Applications, J.H.Fendler John Wiley and Sons. (2007)
4. Textbook of Nanoscience and Nanotechnology, B.S.Murty, et al., Universities Press. (2012)
5. The Nanoscope (Encyclopedia of Nanoscience and Nanotechnology), Dr. Parag Diwan and Ashish Bharadwaj (2005) Vol. IV - Nanoelectronics Pentagon Press, New Delhi.

**WEB SOURCES**

1. www.its.caltec.edu/feyman/plenty.html
2. http://www.library.ualberta.ca/subject/nanoscience/guide/index.cfm
3. http://www.understandingnano.com
4. http://www.nano.gov
5. http://www.nanotechnology.com

# MICROPROCESSOR 8085 AND MICROCONTROLLER 8051

**Learning Objectives**

- To provide an understanding of the architecture and functioning of microprocessor 8085A and to the methods of interfacing I/O devices and memory to microprocessor
- To introduce 8085A programming and applications and the architecture and instruction sets of microcontroller 8051

**UNIT I**

**8085 ARCHITECTURE AND PROGRAMMING**

Functional Building Blocks of a Processor - 8085 Pinout - Hardware Architecture, Bus structure- Memory organization - data transfer concepts–Interrupts- Instruction set- Addressing Modes-Assembly Language Programs- subroutines- Timing Diagrams.

**UNIT II**

**MEMORY I/O PERIPHERAL DEVICES INTERFACING AND APPLICATIONS**

Memory Interface – memory mapped I/O & I/O mapped I/O- Generating Control Signals – Interfacing 2KX8 EPROM – 2KX8 RAM -Interfacing I/O ports to 8085- Hand shake signals - PPI8255- Interfacing 8255 to 8085-LED Interface- seven segment display interface - Programmable DMA controller- Programmable counter /interval timer.

**UNIT III**

**8051 MICROCONTROLLER**

Introduction – Features of 8051 - Pin-out of 8051- architecture - PSW and Flag Bits, Register Banks and Stack, IO Ports Usage - Special Function Registers and their uses -Interrupt Structure-Interrupt Enable Register in 8051-Interrupt Priority Register in 8051- Software Generated Interrupts Register -Internal memory (RAM & ROM) Organization-External Memory.

**UNIT IV**

**8051 INSTRUCTION SET AND ASSEMBLY LANGUAGE PROGRAMMING**

Instruction Set and Addressing modes: Data transfer instructions - Instructions to Access external data memory, external ROM / program memory, PUSH and POP instructions, Data exchange instructions – Logical instructions: byte and bit level logical operations, Rotate and swap operations – Arithmetic instructions: Flags, Incrementing and decrementing, Addition, Subtraction, Multiplication and division, Decimal arithmetic - Jump and CALL instructions: Types of Jumps - Subroutines - Assembly Language Programming.

**UNIT V**

**8051 INTERFACING APPLICATIONS**

Basics of Data acquisition systems – Sensors and Transducers – examples- Multiplexed Seven segment display interface – Wave form generation by interfacing DAC – Interfacing ADC –Stepper motor interface - Measurement of electrical quantities (voltage and current) – Measurement of Temperature and Strain - Interrupt programming and serial communication with 8051.

**TEXT BOOKS**


1. A.NagoorKani, Microprocessors & Microcontrollers, RBA Publications (2009).
2. A.P. Godse and D. A. Godse, Microprocessors, Technical Publications, Pune (2009).
3. Ramesh Gaonkar, Microprocessor Architecture, Programming and Applications with 8085, Penram International Publishing (2013).
4. B.Ram, Fundamentals of Microprocessors & Microcontrollers, DhanpatRai publications New Delhi (2016).
5. V.Vijayendran, 2005, Fundamentals of Microprocessor-8085", 3rd Edition S.Visvanathan Pvt, Ltd.
6. 8051 Micro controller Architecture, Programming and Application by Kenneth .J. AyalaSecond Edition- PRI.
7. 8051 Micro controller and Embedded System by Muhammad Ali Mazidi and Janice Gillispi Mazidi – Pearson Education Publication – 2006


**REFERENCE BOOKS**


1. Douglas V. Hall, Microprocessors and Interfacing programming and Hardware, Tata Mc Graw Hill Publications (2008)
2. Barry B. Brey, 1995, The Intel Microprocessors 8086/8088, 80186, 80286, 80386 and 80486, 3rd Edition, Prentice- Hall of India, New Delhi.
3. J. Uffrenbeck, "The 8086/8088 Family-Design, Programming and Interfacing, Software, Hardware and Applications", Prentice-Hall of India, New Delhi.
4. W. A.Tribel, Avtar Singh, "The 8086/8088 Microprocessors: Programming, Interfacing, Software, Hardware and Applications", PrenticeHall of India, New Delhi.


**WEB SOURCES**

1. https://www.tutorialspoint.com/microprocessor/microprocessor_8085_architectu re.html
2. http://www.electronicsengineering.nbcafe.in/peripheral-mapped-io-interfacing/
3. https://www.geeksforgeeks.org/programmable-peripheral-interface-8255/
4. http://www.circuitstoday.com/8051-microcontroller
5. https://www.elprocus.com/8051-assembly-language-programming/

# MATERIALS SCIENCE

**Learning Objectives**

- To gain knowledge on optoelectronic materials
- To learn about ceramic processing and advanced ceramics
- To understand the processing and applications of polymeric materials
- To gain knowledge on the fabrication of composite materials
- To learn about shape memory alloys, metallic glasses and nanomaterials

**UNIT I**

**OPTOELECTRONIC MATERIALS**

Importance of optical materials – properties: Band gap and lattice matching – optical absorption and emission – charge injection, quasi- Fermi levels and recombination – optical absorption, loss and gain. Optical processes in quantum structures: Inter-band and intra-band transitions Organic semiconductors. Light propagation in materials – Electro-optic effect and modulation, electro-absorption modulation – exciton quenching.

**UNIT II**

**CERAMIC MATERIALS**

Ceramic processing: powder processing, milling and sintering – structural ceramics: zirconia, almina, silicon carbide, tungsten carbide – electronic ceramics – refractories – glass and glass ceramics

**UNIT III**

**POLYMERIC MATERIALS**

Polymers and copolymers – molecular weight measurement – synthesis:
chain growth polymerization – polymerization techniques – glass transition temperature and its measurement – viscoelasticity – polymer processing techniques – applications: conducting polymers, biopolymers and high temperature polymers

**UNIT IV**

**COMPOSITE MATERIALS**

Particle reinforced composites – fiber reinforced composites – mechanical behavior – fabrication methods of polymer matrix composites and metal matrix composites – carbon/carbon composites:fabrication and applications.

**UNIT V**

**NEW MATERIALS**

Shape memory alloys: mechanisms of one-way and two-way shape memory effect, reverse transformation, thermo-elasticity and pseudoelasticity, examples and

applications -bulk metallic glass: criteria for glass formation and stability, examples and mechanical behavior - nanomaterials: classification, size effect on structural and functional properties, processing and properties of Nano crystalline materials,single walled and multi walled carbon nanotubes

**TEXT BOOKS**


1. Jasprit Singh, Electronic and optoelectronic properties of semiconductor structures, Cambridge University Press, 2007
2. P.K. Mallick. Fiber-Reinforced Composites. CRC Press, 2008.
3. V.Raghavan, 2003, Materials Science and Engineering, 4th Edition, Prentice-Hall India, New Delhi(For units 2,3,4 and 5)
4. G.K. Narula, K.S. Narula and V.K. Gupta, 1988, Materials Science, Tata McGraw-Hill
5. M.Arumugam, 2002, Materials Science, 3rd revised Edition, Anuratha Agencies


**REFERENCE BOOKS**


1. B.S. Murty, P. Shankar, B. Raj, B. B. Rath and J. Murday. Textbook of Nanoscience and Nanotechnology. Springer- Verlag, 2012.
2. K.Yamauchi, I. Ohkata, K. Tsuchiya and S. Miyazaki (Eds). Shape Memory and Super Elastic Alloys: Technologies and Applications, Wood head Publishing Limited, 2011.
3. Lawrence H. VanVlack, 1998. Elements of Materials Science and Engineering, 6th Edition, Second ISE reprint, Addison-Wesley.
4. H.Iabch and H. Luth, 2002, Solid State Physics – An Introduction to Principles of Materials Science, 2nd Edition, Springer.
5. D.Hull & T. W. Clyne, An introduction to composite materials, Cambridge University Press, 2008.


**WEB SOURCES**

1. https://onlinecourses.nptel.ac.in/noc20_mm02/preview
2. https://nptel.ac.in/courses/112104229
3. https://archive.nptel.ac.in/courses/113/105/113105081
4. https://nptel.ac.in/courses/113/105/113105025/
5. https://eng.libretexts.org/Bookshelves/Materials_Science/Supplemental_Modules_(Materials_Science)/Electronic_Properties/Lattice_Vibrations

# CHARACTERIZATON OF MATERIALS

**Learning Objectives**

- To make the students learn some important thermal analysis techniques namely TGA, DTA, DSC and TMA.
- To make the students understand the theory of image formation in an optical microscope and to introduce other specialized microscopic techniques.
- To make the students learn and understand the principle of working of electron microscopes and scanning probe microscopes.

- To make the students understand some important electrical and optical characterization techniques for semiconducting materials.
- To introduce the students the basics of x-ray diffraction techniques and some important spectroscopic techniques.

**UNIT I**

**THERMAL ANALYSIS**

Introduction – thermogravimetric analysis (TGA) – instrumentation – determination of weight loss and decomposition products – differential thermal analysis (DTA)-cooling curves – differential scanning calorimetry (DSC) – instrumentation – specific heat capacity measurements – determination of thermomechanical parameters.

**UNIT II**

**MICROSCOPIC METHODS**

Optical Microscopy: optical microscopy techniques – Bright field optical microscopy – Dark field optical microscopy – Dispersion staining microscopy - phase contrast microscopy –differential interference contrast microscopy - fluorescence microscopy - confocal microscopy - - digital holographic microscopy - oil immersion objectives - quantitative metallography - image analyzer.

**UNIT III ELECTRON**

**MICROSCOPY AND SCANNING PROBE MICROSCOPY**

SEM, EDAX, EPMA, TEM: working principle and Instrumentation – sample preparation –Data collection, processing and analysis- Scanning tunnelingmicroscopy (STEM) - Atomic force microscopy (AFM) - Scanning new field optical microscopy.

**UNIT IV**

**ELECTRICAL METHODS AND OPTICAL CHARACTERISATION**

Two probe and four probe methods- van der Pauw method – Hall probe and measurement – scattering mechanism – C-V characteristics – Schottky barrier capacitance – impurity concentration – electrochemical C-V profiling – limitations. Photoluminescence – light – matter interaction – instrumentation – electroluminescence – instrumentation – Applications.

**UNIT V**

**X-RAY AND SPECTROSCOPIC METHODS**

Principles and instrumentation for UV-Vis-IR, FTIR spectroscopy, Raman spectroscopy, ESR, NMR, NQR, XPS, AES and SIMSproton induced X-ray Emission spectroscopy (PIXE) –Rutherford Back Scattering (RBS) analysis-application - Powder diffraction -

Powder diffractometer -interpretation of diffraction patterns - indexing - phase

identification - residual stress analysis - Particle size, texture studies - X-ray fluorescence spectroscopy - uses.

**TEXT BOOKS**


1. R.A. Stradling and P. C. Klipstain. Growth and Characterization of semiconductors. Adam Hilger, Bristol, 1990.
2. J.A. Belk. Electron microscopy and microanalysis of crystalline materials. Applied Science Publishers, London, 1979.
3. Lawrence E. Murr. Electron and Ion microscopy and Microanalysis principles and Applications. Marcel Dekker Inc., New York, 1991
4. D.Kealey and P. J. Haines. Analytical Chemistry. Viva Books Private Limited, New Delhi, 2002.
5. Li, Lin, Ashok Kumar Materials Characterization Techniques Sam Zhang; CRC Press,(2008).


**REFERENCE BOOKS**


1. Cullity, B.D., and Stock, R.S., "Elements of X-Ray Diffraction", PrenticeHall, (2001).
2. Murphy, Douglas B, Fundamentals of Light Microscopy and Electronic Imaging,Wiley-Liss, Inc. USA, (2001).
3. Tyagi, A.K., Roy, Mainak, Kulshreshtha, S.K., and Banerjee, S., Advanced Techniques for Materials Characterization, Materials Science Foundations (monograph series), Volumes 49 – 51, (2009).Volumes 49 – 51, (2009).
4. Wendlandt, W.W., Thermal Analysis, John Wiley & Sons, (1986).
5. Wachtman, J.B., Kalman, Z.H., Characterization of Materials, ButterworthHeinemann, (1993)


**WEB SOURCES**

1. https://cac.annauniv.edu/uddetails/udpg_2015/77.%20Mat%20Sci(AC).pdf
2. http://www.digimat.in/nptel/courses/video/113106034/L11.html
3. https://nptel.ac.in/courses/104106122
4. https://nptel.ac.in/courses/118104008
5. https://www.sciencedirect.com/journal/materials-characterization

# PHYSICS FOR COMPETITIVE EXAMINATIONS

**Learning Objectives**

- To develop the basics of physical principles and the mathematical background important to general mechanics and properties of matter.
- To recollect the ideas of heat and thermodynamics
- Formulation of the concepts of reflection, refraction in optics and longitudinal, transverse waves in sound.
- To explain the formalism of electricity and magnetism
- To discuss the concepts in modern physics.

**UNIT I:**

**GENERAL MECHANICS AND PROPERTIES OF MATTER**

Physical quantities - SI system of units - dimensions - scalars and vectors (Concepts) - Newton's equations of motion - impulse - principle of conservation of linear momentum - projectile motion - Kepler's laws - Newton's law of gravitation - acceleration due to gravity - escape velocity - angular momentum - banking of roads - simple harmonic motion – viscosity - surface Tension.

**UNIT II:**

**HEAT AND THERMODYNAMICS**

Different scales of temperatures - thermal expansions - calorimetry - specific heat - latent heat - triple point - transmission of heat – heat conductivity - Black body radiation - Stefan Boltzmann law - Wien's displacement law - Gas equation - Boyle's law - Charle's law - Law of equipartition of energy.

**UNIT III:**

**LIGHT AND SOUND**

Reflection and refraction - Snell's law - total internal reflection - polarization - Brewster's Law - Huygen's principle – Young's double slit interference and single slit diffraction - longitudinal and transverse waves - velocity of sound - Newton's formula, Laplace correction, effects of pressure - beats - laws of vibrating strings - open and closed organ pipes - resonance.

**UNIT IV:**

**ELECTRICITY AND MAGNETISM**

Coulomb's Law - Electric field due to charged particles: a point charge, a dipole, a line of charge - electric flux - Gauss' law and applications – Biot - Savart law, magnetic field due to a current in: a long straight wire, a circular arc of wire - Ampere's Law - magnetic field outside and inside a long straight wire - solenoids and toroids - Faraday's laws and Lenz's law

**UNIT V:**

**MODERN PHYSICS**

Postulates of Einstein's theory of relativity - Galilean and Lorentz transformation - time dilation - length contraction - Planck's radiation - photoelectric effect - Compton shift, matter waves - Bohr's atomic theory. Nuclear properties - binding energy and mass defect -radioactive decay - alpha decay, beta decay and gamma decay - Radioactive dating.

**TEXT BOOKS**

1. J.Walker, D. Halliday, R. Resnick, Fundamentals of Physics, 10th Edition, Wiley, United states of America, 2007.

2. H.C Verma, Concept of Physics, (Volume I), 1st Edition, Bharati Bhawan Publishers & Distributors, New Delhi, 2008.
3. H.C Verma, Concept of Physics, (Volume II), 1st Edition, Bharati Bhawan Publishers & Distributors, New Delhi, 2008.

**REFERENCE BOOKS**

1. Michael Nelkon, Philip Parker, Advanced Level Physics, 7th Edition, CBS Publishers, India, 1995
2. D.Young Hugh, A. Freedman Roger, University Physics with Modern Physics, 14th Edition, Pearson Education, India, 2017.

**WEB SOURCE**

1. https://hcverma.in/