

# THIRUVALLUVAR UNIVERSITY

## MASTER OF SCIENCE

### M.Sc. PHYSICS

(CBCS Pattern)

(With effect from 2020– 2021)

#### The Course of Study and the Scheme of Examination

Sl. No.	Study Components		ins. hrs / week	Credit	Title of the Paper	Maximum Marks		
	Course Title					CIA	Uni. Exam	Total
<b>SEMESTER I</b>								
1.	Core-Theory	Paper-1	5	4	Mathematical Physics - I	25	75	100
2.	Core-Theory	Paper-2	5	4	Classical and Statistical Mechanics	25	75	100
3.	Core-Theory	Paper-3	5	4	Quantum Mechanics - I	25	75	100
	Core-Practical	Paper-1	4	0	General Practical	0	0	0
	Core-Practical	Paper-2	4	0	Electronics Practical	0	0	0
<b>Internal Elective for same major students</b>								
4.	<b>Core Elective</b>	<b>Paper-1</b>	4	3	(to choose one out of 3) A. Electronic Devices and Applications B. Fiber Optic Communication C. Electronics Communication Systems	25	75	100
<b>External Elective for other major students (Inter/multi disciplinary papers)</b>								
5.	<b>Open Elective</b>	<b>Paper-1</b>	3	3	(to choose one out of 3) A. Energy Physics B. Basic Physics C. Communication Physics	25	75	100
			<b>30</b>	<b>18</b>		<b>125</b>	<b>375</b>	<b>500</b>
<b>SEMESTER II</b>								
6.	Core-Theory	Paper-4	5	4	Mathematical Physics - II	25	75	100
7.	Core-Theory	Paper-5	5	4	Electro Magnetic Theory	25	75	100
8.	Core-Theory	Paper-6	4	4	Quantum Mechanics - II	25	75	100
9.	Core-Practical	Paper-1	4	4	General Practical	25	75	100
10.	Core-Practical	Paper-2	4	4	Electronics Practical	25	75	100
<b>Internal Elective for same major students</b>								
11.	<b>Core Elective</b>	<b>Paper-2</b>	3	3	(to choose one out of 3) A. Nanoscience B. Electronics Instrumentation C. Non-linear optics	25	75	100
<b>External Elective for other major students (Inter/multi disciplinary papers)</b>								

12.	<b>Open Elective</b>	<b>Paper-2</b>	3	3	(to choose one out of 3) A. Spectroscopy and Lasers B. Physics for Competitive Exams C. Analog and Digital Electronics	25	75	100
13.	<b>*Field Study</b>		-	2		100	-	100
14.	<b>Compulsory Paper</b>		2	2	<b>Human Rights &amp; Duties</b>	25	75	100
			<b>30</b>	<b>30</b>		<b>300</b>	<b>600</b>	<b>900</b>

### SEMESTER III

						<i>CIA</i>	<i>Uni. Exam</i>	<i>Total</i>
15.	Core-Theory	Paper-7	5	5	Condensed Matter Physics	25	75	100
16.	Core-Theory	Paper-8	5	5	Nuclear Physics	25	75	100
17.	Core-Theory	Paper-9	4	4	Microprocessors and Microcontrollers	25	75	100
	Core-Practical	Paper-3	5	-	Advanced General Experiments	0	0	0
	Core-Practical	Paper-4	5	-	Programming & Problem solving skills	0	0	0

#### Internal Elective for same major students

18.	Core Elective	Paper-3	3	3	(to choose one out of 3) A. Research methodology B. Material Science C. Numerical Methods and C programming	25	75	100
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#### External Elective for other major students (Inter/multi disciplinary papers)

19.	Open Elective	Paper-3	3	3	(to choose one out of 3) A. Electrical and Electronics Appliances B. Physics of Materials C. Geophysics	25	75	100
20.	<b>**MOOC Courses</b>		-	-	Choose any two courses from the list given	0	0	100
			<b>30</b>	<b>20</b>		<b>125</b>	<b>375</b>	<b>600</b>

### SEMESTER IV

						<i>CIA</i>	<i>Uni. Exam</i>	<i>Total</i>
21.	Core-Theory	Paper-10	6	3	Spectroscopy	25	75	100
22.	Core-Practical	Paper-3	5	4	Advanced General Experiments	25	75	100
23.	Core-Practical	Paper-4	5	4	Programming & Problem solving skills	25	75	100
24.	<b>Core</b>	<b>Project</b>	5	5	Project with viva voce (Compulsory)	100 (75 Project +25 viva)		100

#### Internal Elective for same major students

25.	<b>Core Elective</b>	<b>Paper-4</b>	<b>6</b>	3	(to choose one out of 3) A. Crystal Growth and Thin Films B. Medical Physics C. MATLAB and Python Programming	25	75	100
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#### External Elective for other major students (Inter/multi disciplinary papers)

26.	<b>Open Elective</b>	<b>Paper-4</b>	3	3	(to choose one out of 3) A. Nanophysics B. Astrophysics C. Weather forecasting	25	75	100
			<b>30</b>	<b>22</b>		<b>125</b>	<b>475</b>	<b>600</b>
			<b>120</b>	<b>90</b>				<b>2600</b>

**\* Field Study**

There will be field study which is compulsory in the first semester of all PG courses with 2 credits. This field study should be related to the subject concerned with social impact. Field and Topic should be registered by the students in the first semester of their study along with the name of a mentor before the end of the month of August. The report with problem identification and proposed solution should be written in not less than 25 pages in a standard format and it should be submitted at the end of second semester. The period for undergoing the field study is 30 hours beyond the instructional hours of the respective programme. Students shall consult their mentors within campus and experts outside the campus for selecting the field and topic of the field study. The following members may be nominated for confirming the topic and evaluating the field study report.

- (i). Head of the respective department
- (ii). Mentor
- (iii). One faculty from other department

**\*\*Mooc Courses**

Inclusion of the Massive Open Online Courses (MOOCs) with zero credits available on SWAYAM, NPTEL and other such portals approved by the University Authorities.

## SEMESTER III

### PAPER-7

## CONDENSED MATTER PHYSICS

### Course Objectives

1. To understand the basic crystal structures, bonding of solids and the lattice energy calculations.
2. To study the lattice dynamics and phonon momentum.
3. To explain the free electron gas in three dimensions and electronic heat capacity.
4. To understand basic concept of magnetism and its applications.
5. To study the properties of superconducting materials and its applications.

### Unit-1: Crystal Physics

Types of lattices - Miller indices – symmetry elements and allowed rotations - simple crystal structures – Atomic packing factor - Crystal diffraction - Bragg's law – Scattered wave amplitude - Reciprocal lattice (sc, bcc, fcc) – Diffraction conditions - Laue equations – Brillouin Zone - Structure factor - Atomic form factor - Inert gas crystals.

### UNIT-2: Lattice Dynamics

Monoatomic lattices - Lattice with two atoms per primitive cell - First Brillouin zone - Group and phase velocities - Quantization of lattice vibrations - Phonon momentum - Inelastic scattering by phonons - Einstein's model and Debye's model of specific heat.

### UNIT-3: Band theory of metals and Semiconductors

Free electron gas in three dimensions - Electronic heat capacity - Wiedmann-Franz law - Band theory of metals and semiconductors - Bloch theorem - Kronig-Penny model - Semiconductors - Intrinsic carrier concentration – Temperature dependence - Mobility - Impurity conductivity – Impurity states - Hall effect.

### UNIT-4: Magnetism

Diamagnetism - quantum theory of Paramagnetism - Rare earth ion - Hund's rule - Quenching of orbital angular momentum - Adiabatic demagnetization - Quantum theory of ferromagnetism - Curie point - Exchange integral - Heisenberg's interpretation of Weiss field - ferromagnetic domains - Bloch Wall - Spin waves - Quantization - Magnons - thermal excitation of magnons

### UNIT-5: Super conductors and its applications

Experimental facts: Occurrence - Effect of magnetic fields - Meissner effect – Critical field – Critical current - Entropy and heat capacity - Isotope effect - Energy gap - Type I and Type II superconductors. Theoretical explanation: Thermodynamics of super conducting transition -

London equation - BCS Theory - Coherence length -- Cooper pairs - Single particle Tunneling - Josephson tunneling - DC and AC Josephson effects - High temperature super conductors - SQUIDS.

### **Text Books**

#### **Unit 1 to Unit 5**

1. S.O. Pillai, Solid State Physics, New Age International, New Delhi, 2016.

### **Reference Books**

1. C. Kittel, Introduction to Solid State Physics, 7th Edition, Wiley, New York, 1996.
2. M. Ali Omar, Elementary Solid State Physics-Principles and Applications, Addison-Wesley, London, 1974.
3. K. Ilangoan, Solid State Physics, S. Viswanathan (Printers&Publishers) Pvt.Ltd.,Chennai,2007.
4. N.W. Aschroft, N.D. Mermin, Solid State Physics, Rhinehart and Winton, New York.
5. J.S. Blakemore, Solid State Physics, 2nd Edition, W.B. Saunder, Philadelphia, 1974.
6. A.J. Dekker, Solid State Physics, Macmillan India, New Delhi.
7. H.M. Rosenburg, The Solid State, 3rd Edition, Oxford University Press, Oxford, 1993.
8. S.L. Altmann, Band Theory of Metals, Pergamon, Oxford.
9. M.A. Wahab, Solid State Physics, Structure and Properties of Materials, Narosa, New Delhi, 1999.
11. J.M. Ziman, Principles of the Theory of Solids, Cambridge University Press, London, 1971.

### **E-Materials**

1. [https://web.iit.edu/sites/web/files/departments/academic-affairs/academic-resource-center/pdfs/Miller\\_Indices.pdf](https://web.iit.edu/sites/web/files/departments/academic-affairs/academic-resource-center/pdfs/Miller_Indices.pdf)
1. [https://www.youtube.com/watch?v=LcoUFX3\\_A1s](https://www.youtube.com/watch?v=LcoUFX3_A1s)
2. <https://www.youtube.com/watch?v=-MTYPNfVw5Y>
3. [https://en.wikipedia.org/wiki/Brillouin\\_zone](https://en.wikipedia.org/wiki/Brillouin_zone)
4. [http://yclept.ucdavis.edu/course/215b.W17/Kronig-Penney\\_Rapp-3.pdf](http://yclept.ucdavis.edu/course/215b.W17/Kronig-Penney_Rapp-3.pdf)
5. <https://www.youtube.com/watch?v=6EdotZPaCIA>
6. <https://www.youtube.com/watch?v=IMbGqcb8aN4>
7. [https://en.wikipedia.org/wiki/Hund%27s\\_rules](https://en.wikipedia.org/wiki/Hund%27s_rules)
8. [https://en.wikipedia.org/wiki/Meissner\\_effect](https://en.wikipedia.org/wiki/Meissner_effect)
9. <https://www.youtube.com/watch?v=NVeAmKUbxvA>

## Course Outcomes

1. After studied unit-1, the student will be able to know the types of lattices and crystal structures.
2. After studied unit-2, the student will be able to explain lattice dynamics like Einstein's model and Debye's model of specific heat.
3. After studied unit-3, the student will be able to study Band theory of metals and semiconductors and also able to explain Kronig-Penny model.
4. After studied unit-4, the student will be able to understand the quantum theory of paramagnetism and ferromagnetism.
5. After studied unit-5, the student will be able to basics of superconductors and its applications. Also able to differentiate Type I and Type II superconductors.

## PAPER-8

### NUCLEAR PHYSICS

#### Course Objectives

1. To teach the basic properties of nuclear properties like energy levels, angular momentum, parity and isospin.
2. To study the alpha, beta, gamma decay and nuclear reactions.
3. To acquire the knowledge on different nuclear models
4. To know the principle and working of nuclear detectors.
5. To learn the classification of elementary particles and its properties.

#### UNIT-1: Nuclear Properties

Nuclear energy levels - Nuclear angular momentum, parity, isospin – Nuclear magnetic dipole moment – Nuclear electric quadrupole moment - Ground state of deuteron – Magnetic dipole moment of deuteron – Proton-neutron scattering at low energies – Scattering length, phase shift – Nature and properties of nuclear forces – Spin dependence – Charge symmetry – Charge independence – Repulsion at short distances – Exchange forces – Meson theory.

#### UNIT-2: Decay and Reactions

Alpha decay: Energy relations - Q values – Spectrum and selection rules - Gamow's theory.  
Beta decay: Energy relations - Q values – Spectrum - Pauli's neutrino hypothesis – Electron capture - Fermi's theory of beta decay – Selection rules .  
Gamma decay- Kinematics of Gamma decay – Spectrum – Internal conversion – Selection rules  
Nuclear Reactions -Types and conservation laws – Q-equation -Threshold energy -General solution of the Q equations – Cross section of nuclear reactions –Scattering and reaction cross section - Compound nucleus model -Breit Wigner single level formula-Ghosal's experiment

#### UNIT-3: Nuclear Models

Liquid drop model: Semi empirical mass formula – Applications of LDM - Mass parabola – Q-values (Alpha, Beta and Fission) – Energetics of fission – Fissility parameter - Bohr-Wheeler's theory Shell model:Evidences in favour of shell model - Shell model potential – Square well, Harmonic Oscillator, Woods-Saxon – Spin – Orbit coupling – Nuclear Ground state configuration and spin parity – Nuclear moment – Nuclear isomerism – Predictions and failures of the shell model Collective model: Vibrational model – Rotational model – Quadrupole moment – Fermi gas model

#### UNIT-4: Detectors and applications

Detectors: General Properties- Energy proportionality – Pulse shape – Energy resolution – Detection efficiency – Time resolution - Ionization Chamber – Geiger-Muller counter – Scintillation detectors – Semiconductor detectors Accelerators –Linear Accelerator – Cyclotron – Large Hadron Collider.

Applications – Neutron activation analysis – Rutherford backscattering spectrometry – Accelerator mass spectroscopy

### **UNIT-5: Elementary Particles**

Nucleons, leptons, mesons, baryons, hyperons, hadrons, strange particles -Classification of fundamental forces and elementary particles – Basic conservation laws-Additional conservation laws: Baryonic, leptonic, strangeness and isospin charges/quantum numbers – Gell-mann--Nishijima formula - Invariance under charge conjugation (C), parity (P) and time reversal (T) -CPT theorem -Parity non-conservation in weak interactions – CP violation – Eight-fold way and supermultiplets – SU(3) symmetry and quark model-Gell – Mann Okubo mass formula for octet and decuplet-Ideas of Standard model and Higgs particle.

#### **Text Books**

1. K. S. Krane, Introductory Nuclear Physics, John-Wiley, New York, (1987).
2. S. B. Patel, Nuclear Physics: An Introduction, Wiley-Eastern, New Delhi, (1991).
3. B. L. Cohen, Concepts of Nuclear Physics, Tata McGraw Hill, New Delhi, (1988).
4. M.L Pandya and R.P.S Yadav, Elements of Nuclear Physics, KedarNath Ram, Meerat (1994).

#### **Reference Books**

1. H. S. Hans, Nuclear Physics: Experimental and Theoretical, New Age International Publishers, New Delhi, (2001).
1. D. C. Cheng and G. K. O'Neill, Elementary Particle Physics: An Introduction, Addison-Wesley, (1979).

#### **E-Materials**

1. <https://www.youtube.com/watch?v=Jf6MSWoZRmc>
2. [http://www.scholarpedia.org/article/Nuclear\\_Forces](http://www.scholarpedia.org/article/Nuclear_Forces)
3. [https://en.wikipedia.org/wiki/Alpha\\_decay](https://en.wikipedia.org/wiki/Alpha_decay)
4. <https://www.youtube.com/watch?v=CwExbnOzc4o>
5. <https://www.youtube.com/watch?v=nqSs7vrF9DY>
6. <http://hyperphysics.phy-astr.gsu.edu/hbase/Nuclear/liqdrop.html>
7. [https://en.wikipedia.org/wiki/Geiger\\_counter](https://en.wikipedia.org/wiki/Geiger_counter)
8. <https://www.youtube.com/watch?v=jxY6RC52Cf0>
9. [https://www.youtube.com/watch?v=fivOAjr\\_suA](https://www.youtube.com/watch?v=fivOAjr_suA)
10. [https://en.wikipedia.org/wiki/Gell-Mann%E2%80%93Nishijima\\_formula](https://en.wikipedia.org/wiki/Gell-Mann%E2%80%93Nishijima_formula)

#### **Course Outcomes**

1. After studied unit-1, the student will be able to understand the concept of nuclear energy levels, nuclear angular momentum, parity and isospin. Also able to explain nature and properties of nuclear forces.



2. After studied unit-2, the student will be able to describe Gamow's theory, Fermi's theory of beta decay and kinematics of gamma decay. Also able to derive the Breit Wigner single level formula.
3. After studied unit-3, the student will be able to differentiate different nuclear models.
4. After studied unit-4, the student will be able to know the principle and working of G.M. counter, scintillation detectors and particle accelerators.
5. After studied unit-5, the student will be able to obtain Gell-mann--Nishijima formula and Gell – Mann Okubo mass formula. Also able to explain the classification of elementary particles.

## **PAPER-9**

### **MICROPROCESSOR (8085) & MICROCONTROLLER (8051)**

#### **Course Objectives**

1. To learn interrupts of 8085, Timing diagram and assembly language programming.
2. To understand the principle of interfacing with peripheral devices
3. To acquire new knowledge on fundamentals of microcontroller 8051.
4. To study the Interrupts and instructions set of 8051 and hence to acquire the knowledge on Programming.
5. To expose PUSH and POP, Jump and Call instructions and some interfacing devices.

#### **Unit-1: Instructions & ALP**

8085- Instructions- Data transfer, Arithmetic, Logical, Branch and I/O and Machine Control Instructions-Timing Diagram for Memory Read/Write Cycle-Timing diagram for MOV/MVI instructions-Delay Calculations-Time delay using a single register-Two register-Register pair.

Assembly language programs -8-bit Addition with Carry-Multibyte addition-8-bit Subtraction with Borrow-Multibyte subtraction-BCD subtraction-16-bit Multiplication-BCD Multiplication-8-bit Division-BCD division-Square and Square root-Largest and smallest numbers in a data set – Ascending order and descending order –Binary to ASCII-ASCII to Binary-BCD to ASCII and ASCII to BCD-Debugging a program.

#### **Unit-2: Peripheral Devices and Interface (8085)**

Data transfer schemes -- Synchronous and asynchronous data transfer-Interfacing memory and devices- I/O and Memory mapped I/O – Pin function, working and interfacing of Programmable peripheral interface (8255)-Programmable keyboard / display interface (8279)-Interfacing Seven segment display interface-Block diagram and interfacing of analog to digital converter (ADC ) and Digital to analog converter (DAC)- Steppermotor with clockwise and anti-clockwise rotation-Traffic control.

#### **Unit-3: Basic of Microcontroller 8051**

8051 Micro-controller hardware: 8051 oscillator and clock - Program counter and data pointer - A and B CPU register - Flags and PSW - Internal memory - Internal RAM - Stack and stack pointer - Special function registers - Internal ROM-Input / output pin, ports and circuits - External memory.

Counter and Timer: Counter / Timer interrupts - Timing - Timer modes of operation – Counting-Serial data input / Output: Serial data interrupt - Data transmission - Data reception - serial data transmission modes.

#### **UNIT-4: Interrupts & Instructions**

Interrupts: Timer flag interrupt - Serial port interrupt - External interrupt - reset - Interrupt control - Interrupt priority - Interrupt destination - Software generated interrupts.

Introduction - Addressing modes - Byte level logic operations - Bit level logic operations - Rotate and swap operations - Simple program.

Arithmetic Operations: Introduction - Flags - Incrementing and Decrementing - Addition - Subtraction - Multiplication and Division - Simple Program.

### **Unit-5: Instructions & Interfacing**

Introduction - External data move - code memory read only data move - PUSH and POP - Opcodes - Data exchange - Simple Programs.

Jump and Call instructions: Introduction - Jump and call program range - Jumps - Calls and subroutine - Interrupt and returns - more detail on interrupts - Simple programs.

Keyboard interfacing - Display interface - 7 segment and LED display - D/A conversion - A/D conversion - Stepper motor Interface.

### **Text Books**

#### **Unit-1 to Unit-2**

1. V.Vijayendran, Fundamentals of Microprocessor 8085 - Architecture, programming and interfacing, S.Viswanathan (Printers & Publishers) Pvt, Ltd, Chennai, 2008.
2. A. NagoorKani, 8085 Microprocessor and its Applications, Tata McGraw –Hill Education Private Ltd, New Delhi,2013.

#### **Unit-3 to Unit-5**

1. Kenneth Ayala, The 8051Microcontroller,Cengage Learning India, New Delhi, 2013.

### **Reference Books**

1. R.S. Gaonkar, ‘Microprocessor Architecture Programming and Application’, with 8085, Wiley Eastern Ltd., New Delhi, 2013.
2. B. Ram, Fundamentals of Microprocessors and Microcomputers, DhanpatRai publications, New Delhi.
3. Krishna Kant, “Microprocessor and Microcontrollers”, Eastern Company Edition, Prentice Hall of India, New Delhi , 2007.
4. Soumitra Kumar Mandal, Microprocessor & Microcontroller Architecture, Programming & Interfacing using 8085,8086,8051,McGraw Hill Edu,2013.

5. Muhammed Ali Mazidi, Janice Gillespie Mazidi and Rolin D McKinlay, The 8051 Microcontroller and Embedded Systems, Pearson Education , 2013.
6. P.S. Manoharan, Microprocessors and Microcontroller, Charulatha Publications.

### **E-Materials**

1. [https://en.wikipedia.org/wiki/Intel\\_8085](https://en.wikipedia.org/wiki/Intel_8085)
2. [https://www.youtube.com/watch?v=fS7FFOaC\\_iQ](https://www.youtube.com/watch?v=fS7FFOaC_iQ)
3. <https://www.youtube.com/watch?v=tC4WvbM3hZA>
4. <http://www.uomisan.edu.iq/eng/ar/admin/pdf/90949589293.pdf>
5. <https://www.pantechsolutions.net/how-to-interface-stepper-motor-with-8085-lab-trainer-kit>
6. <http://www.8085projects.info/Stepper-Motor-control-Program70.html>
7. <https://www.youtube.com/watch?v=shJAszu34xY>
8. <https://www.elprocus.com/8051-microcontroller-architecture-and-applications/>
9. [https://www.youtube.com/watch?v=iXSXIjN\\_Xwc](https://www.youtube.com/watch?v=iXSXIjN_Xwc)
10. <https://www.electronicshub.org/stepper-motor-control-using-8051-microcontroller/>
11. <https://circuitdigest.com/microcontroller-projects/stepper-motor-interfacing-with-8051>

### **Course Outcomes**

1. After studied unit-1, the student will be able to know various interrupts, timing diagram for memory read/write cycle and able to write assembly language programs.
2. After studied unit-2, the student will be able to describe the different interfacing devices and can demonstrate the interfacing of DAC/ADC and stepper motor with 8085.
3. After studied unit-3, the student will be able to understand the hardware of 8051, memories, Counter and Timer.
4. After studied unit-4, the student will be able to explain the interrupts, addressing modes and arithmetic operations.
5. After studied unit-5, the student will be able to describe PUSH-POP, jump and call instructions and able to know how to interface the peripheral devices with 8051.

**CORE ELECTIVE  
PAPER -3**

**(to choose 1 out of 3)**

**A. RESEARCH METHODOLOGY**

**Course Objectives**

1. To teach the basics of research philosophies and research approaches.
2. To know how to do the review of literature.
3. To expose the importance of internet in research.
4. To learn how to write a thesis or paper.
5. To understand the different numerical methods.

**UNIT-1: Basics of Research**

Understanding Research Philosophies and Approaches -Meaning, Objectives and Motivation in research - Types of research - Research Approaches - Research Process - Validity and Reliability in research.

Research Design -Features of a good design - Types of Research Design - Basic principles of Experimental Design-Survey Design-Classroom-Based Research. Sampling Design - Steps in Sample Design - Characteristics of a good sample design - Random Samples and Random Sampling Design.

**UNIT-2: Review of literature**

Survey of literature including patents - chemical nomenclature and literature primary sources-secondary sources including reviews. Treatise and monographs, literature searching, Review of work relevant to the chosen problems.

**UNIT-3: Internet and Presentation**

Internet and its applications-Search engines- Wikipedia-Web of Science- SCOPUS-BASE-CORE-Google Scholar-Science Hub.

Presentation: Presenting articles in Seminars, workshops, conferences and symposia.

Publication of research paper:e-journals- National, International and Electronic Journals -UGC CARE list Journals- Open access articles benefits-citations-impact factor, h-index- copy rights-Intellectual property rights and patents.

**UNIT-4 : Writing methods**

Writing a thesis or paper - General formation - page and chapter formation. The use of quotation - footnotes - tables and figures - referencing - appendixes - revising the paper or

thesis - editing and evaluating and the final product - proof reading -Plagiarism-the final types copy.

### **UNIT-5: Numerical methods**

Linear Interpolation-Gregory-Newton forward and Backward Interpolation formula--Gauss forward and backward interpolation formula.

Numerical Differentiation:-Modified Euler's method-Runge-Kutta second and fourth order method for solving first order differential equations.

Numerical Integration: Trapezoidal rule-Simpson's 1/3rd rule .

### **Text Books**

#### **Unit 1 to Unit 4**

1. J Anderson, B.H. Dursten and M. Poole , Thesis and Assignment Writing, Wiley Eastern,1977.
2. C.R.Kothari, Research Methodology: Methods and Techniques. New Delhi: New Age International (P) Publishers, 2004.

#### **Unit 5**

1. S.S. Sastry, Introductory Methods of Numerical analysis, PHI, N.Delhi
2. E. Balagurusamy, Numerical Methods,Tata McGraw Hill, New Delhi, 2013.

### **Reference Books**

1. R.Kumar, Research Methodology: A Step-by-Step Guide for Beginners.London: Sage Publications, (2011).
2. J.H. Mathews, Numerical Methods for Mathematics, Science and Engineering Prentice-Hall of India, New Delhi, 1998.
3. P.B. Patil and U.P. Verma, Numerical Computational Methods (Narosa, New Delhi, 2013.
4. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation (New Age International, New Delhi, 1993
5. M.K.Venkataraman, Numerical methods in Science and Engineering, National Publishing Company, Chennai ,2004.

## **E-Materials**

1. [https://en.wikipedia.org/wiki/Research\\_design](https://en.wikipedia.org/wiki/Research_design)
2. <https://study.com/academy/lesson/types-of-research-design.html>
3. <https://www.scribbr.com/dissertation/literature-review/>
4. [https://www.youtube.com/watch?v=-ny\\_EUJXHHs](https://www.youtube.com/watch?v=-ny_EUJXHHs)
5. <https://www.youtube.com/watch?v=XDfgdwMBPfc>
6. <https://www.colorado.edu/history/undergraduates/paper-guidelines/using-internet-research>
7. [https://www.ldeo.columbia.edu/~martins/sen\\_sem/thesis\\_org.html](https://www.ldeo.columbia.edu/~martins/sen_sem/thesis_org.html)
8. <https://www.wikihow.com/Write-a-Thesis-Statement>
9. <https://www.youtube.com/watch?v=gt3QZgMNq3s>
10. [https://en.wikipedia.org/wiki/Simpson%27s\\_rule](https://en.wikipedia.org/wiki/Simpson%27s_rule)

## **Course Objectives**

1. After studied unit-1, the student will be able to know the basics of research theories, approaches and design.
2. After studied unit-2, the student will be able to demonstrate what do you mean by review of literature and know how to proceed the research work based on review of literature.
3. After studied unit-3, the student will be able to explain the importance of internet in the field of research.
4. After studied unit-4, the student will be able to how to write a thesis or a research paper. Also students will be able to learn how to present a research article in a seminar/conference or how to publish the article in e-journals.
5. After studied unit-5, the student will be able to formulate the Euler's method, Range Kutta method, Trapezoidal rule and Simpson's 1/3rd rule of numerical methods.

**CORE ELECTIVE  
PAPER -3**

**B. MATERIALS SCIENCE**

**Course Objectives**

1. To understand the basic concepts of phase transition materials.
2. To learn the introduction on ceramic and polymer materials.
3. To teach biomaterials for biomedical applications.
4. To expose the knowledge on nonlinear optical materials.
5. To give an idea about energy conversion and storage materials

**UNIT-1: Phase transition materials**

Definition and basic concepts - solubility limit -phases - microstructure –phase equilibria – unary phase diagrams-Binary phase diagrams – Binary isomorphous systems – Interpretation of phase diagrams-Development of microstructure in isomorphous alloys -mechanical properties of isomorphous alloys- Binary eutectic systems – Development of microstructure in eutectic alloys – Equilibrium diagrams having intermediate phases or components – Eutectoid and peritectic reactions -Concurrent phase transformations -ceramics and ternary phase diagrams -The Gibbs phase rule - The iron – iron carbide phase diagrams.

**UNIT-2: Ceramics and Polymers**

Ceramics: Introduction -Glasses - Glass Ceramics - clay products – refractory's –abrasives-cements – advanced ceramics - ceramic phase diagrams - brittle fracture of ceramics- stress - strain behavior – mechanism of plastic deformation – miscellaneous mechanical consideration.

Polymers - Polymerization mechanism - Polymer structures - Deformation of polymers - Behaviour of polymers,

**UNIT-3: Biomaterials**

Introduction to biomaterials for biomedical applications, Chemical structure and property of biomaterials, Degradation of biomaterials, Polymeric biomaterials: Introduction, preparation, hydrogel biomaterials, Bioconjugation techniques, Biomaterials for drug delivery application (small molecules, gene and protein)-Biomaterials implantation- Biomaterials for imaging and diagnosis.

**UNIT-4: NLO materials**

Introduction-Harmonic Generation-Second Harmonic Generation-Phase Matching-Third Harmonic Generation-Optical Mixing-Parametric Generation of Light-Selffocusing of Light–nonlinear optical materials.

**UNIT-5: Energy conversion and Storage materials**



Solar cells: Organic solar cells - Polymer composites for solar cells - p-njunction - Device fabrication and characterization – Nanomaterials for solar cells - Dye-sensitized solar cells - Organic - inorganic hybrid solar cells.

Batteries -primary and secondary batteries, Lithium, Solid-state and molten solvent batteries; Lead acid batteries; Nickel Cadmium Batteries; Advanced Batteries, Super capacitors for energy storage. Role of carbon nanomaterials as electrodes in batteries and super capacitors.

### **Text Books**

#### **Unit 1 to Unit 5**

1. G.K. Narula, K.S. Narula, and V.K. Gupta, Material Science, TMH, New Delhi, 1995.
2. Dr. M.N. Avadhanulu, Material science, S.Chand & Company, New Delhi, 2014
3. V.Ragavan, Material Science and Engineering, 4<sup>th</sup> Edition, Prentice Hall of India, New Delhi, 2003.
4. M. Arumugam, Materials Science, 3<sup>rd</sup> Edition, Anuradha Agencies, 2002.

### **Reference Books**

1. Lawrence H. Vlack, Elements of Materials Science and Engineering, 6<sup>th</sup> Edition, Second ISE reprint, Addison-Wesley, 1998.
2. H. Ibach, H. Luth, Solid State Physics, An introduction to principles of Material Science, 2<sup>nd</sup> Edition, Springer, 2001.
3. Balasubramanian. R., Callister's, Material Science and Engineering, Wiley, India, 2010.
4. A.J. Dekker, Solid State Physics, McMillan Co., 1981.

### **E-Materials**

1. [https://www.tf.uni-kiel.de/matwis/amat/iss/kap\\_6/illustr/s6\\_1\\_1.html](https://www.tf.uni-kiel.de/matwis/amat/iss/kap_6/illustr/s6_1_1.html)
2. <https://www.youtube.com/watch?v=3EFu2t94Mrw>
3. <https://www.youtube.com/watch?v=vnVPwf2T4Eo>
4. <https://en.wikipedia.org/wiki/Glass-ceramic>
5. <https://en.wikipedia.org/wiki/Biomaterial>
6. <https://nptel.ac.in/courses/113104009/>
7. <https://www.slideshare.net/krishslide/nonlinear-optical-materials>
8. <https://shodhganga.inflibnet.ac.in/bitstream/10603/36565/4/chapter%201.pdf>
9. [https://en.wikipedia.org/wiki/Dye-sensitized\\_solar\\_cell](https://en.wikipedia.org/wiki/Dye-sensitized_solar_cell)
10. <https://www.youtube.com/watch?v=17SsOKEN5dE>

### **Course Outcomes**

1. After studied unit-1, the student will be able to know the concepts of phase diagrams and phase transformations.
2. After studied unit-2, the student will be able to explain the property of ceramic materials and also able to learn polymerization mechanism.

3. After studied unit-3, the student will be able to explain the chemical structure and property of biomaterials.
4. After studied unit-4, the student will be able to understand the properties NLO materials and its harmonic generation.
5. After studied unit-5, the student will be able to design the energy conversion and storage materials.

**CORE ELECTIVE  
PAPER -3**

**C. NUMERICAL METHODS & C PROGRAMMING**

**Course Objectives**

1. To learn the fundamentals of numerical differential and integration
2. The course gives the principles of scientific research
3. Students can study the basics of C programming
4. To acquire knowledge on operator, arrays and strings
5. To teach how to write the simple programs using C language

**UNIT-1: Numerical methods**

Solutions of equations - Simple iterative methods - Newton - Raphson method - Numerical Integration - Simpson's 3/8 rule - RungeKutta method II order - Solution of Simultaneous equation.

**UNIT-2: Principles of Scientific Research**

Identification of the problem - Literature survey - Reference collection - Familiarity with ideas and concept of investigation – Use of Internet in research - Drawing Inferences from data – Qualitative and Quantitative analysis - Results – Presentation in a Seminar - Synopsis writing - Art of writing a Research paper and Thesis - Power point presentation

**UNIT-3: Programming in C**

Introduction –Importance of C language - Basic structure of C Programming - Character set - constants - Keywords - Identifiers - Variables - declaration of variables - Assigning values to variables - defining symbolic constants – Types of Operators - Arithmetic, relational, logical, assignment, increment, decrement conditional and special type conversion in Expressions.

**UNIT-4: Operators, Arrays and Strings**

Arrays:Introduction - one, two and multi-dimensional arrays - Initializing two dimensional arrays - Declaring and Initialising string variables - Reading and Writing Strings on the screen – Arithmetic operations on strings.

**UNIT-5: Simple Programs**

Multiplication programs - Return values and their types - Calling Functions - Categories of functions - Matrix multiplication - Diagonalisation and inversion - Solution to simultaneous equations - differential and integral equations.

**Text Books**

**Unit 1**

1. S.S. Sastry, Introductory Methods of Numerical analysis, PHI, N.Delhi
2. E. Balagurusamy, Numerical methods, Tata McGraw-Hill, Delhi

## Unit 2

1. J. Anderson B.H. Burston and M. Poole, Thesis and Assignment writing, Wiley, UK,1977
2. Rajammal.P. Devadas, Hand book of Methodology of Research, RMM Vidyalaya Press. 1976

## Unit 3- Unit 5

1. E. Balagurusamy, Programming in ANSI C, 4<sup>th</sup> Edition TMH, New Delhi, 2009
2. V. Rajaraman, 1993, Computer Oriented Numerical Methods, 3rd Edition, PHI, New Delhi.

## Reference Books

1. V. Rajaraman, Programming in C, PHI, New Delhi.
2. C.R. Kothari, Research methodology : Methods and Techniques, New Age International Publishers
3. S.D. Conte and C.de Boor, Elementary Numerical analysis-an algorithmic approach, 3rd Edition, McGraw Hill,1981
4. B.F. Gerald, and P.O. Wheatley, Applied Numerical analysis, 5th Edition, Addison-Wesley, M.A,1994

## E-Materials

1. <https://nptel.ac.in/courses/122102009/>
2. <httphttps://www.scribbr.com/dissertation/literature-review/s://math.dartmouth.edu/~m3cod/klbookLectures/406unit/trap.pdf>
3. <https://uscupstate.libguides.com/c.php?g=627058&p=4389968>
4. <https://www.geeksforgeeks.org/c-language-set-1-introduction/>
5. <https://www.youtube.com/watch?v=KJgsSFOSQv0>
6. <https://www.youtube.com/watch?v=aMpsKnf6DrQ>
7. <https://www.studytonight.com/c/programs/>
8. <https://www.youtube.com/watch?v=Yzfl3rtF0SM>
9. <https://learnenglish.britishcouncil.org/writing-purpose/literature-surveys-structure-1>
10. [https://www.tutorialspoint.com/cprogramming/c\\_arrays.htm](https://www.tutorialspoint.com/cprogramming/c_arrays.htm)

## Course Outcomes

1. After studied unit-1, the student will be able to get the solutions using different numerical methods.
2. After studied unit-2, the student will be able to explain the fundamentals of research and know how to write a thesis or paper.
3. After studied unit-3, the student will be able to understand the basic structure of C programming.
4. After studied unit-4, the student will be able to learn the one, two and multidimensional arrays and also know the reading and writing strings.
5. After studied unit-5, the student will be able to write different programs after learning the structure of C programming.

**OPEN ELECTIVE  
PAPER -3  
(to choose 1 out of 3)**

**A. ELECTRICAL AND ELECTRONICS**

**Course Objectives**

1. The course gives the some fundamental knowledge of electrical and electronics technology
2. To identify the discrete components will be used in electrical circuits
3. To know basics of household electrical connections
4. To expose the principle and design of electrical appliances used in our day-today life
5. To teach basics of semiconductors and related electronics circuits
6. To give the fundamentals and working design of consumer electronics appliances

**UNIT-1: Basics of Electrical Technology I**

Resistance and its types – capacitance and its types – Colour codes-inductance and its units – Transformers – Electrical Charge – Current – Electrical Potential-Ohm’s law – Galvanometer, Ammeter, Voltmeter and Multimeter -Analog and Digital - Electrical Energy -Power – Watt – kWh – Consumption and electrical power.

**UNIT-2: Basics of Electrical Technology II**

AC-Single phase and three phase connections - House wiring – Star and delta connection – overloading-Earthing-short circuiting-Fuses-Colour code for insulation wires- Transformers

**UNIT-3: Electrical Appliances**

Electric iron Box-Electric Fan-Construction and Working of Ceiling and Table fans-Water Heater –Types-Function -Wet Grinder-Mixer Grinder-Principle and Design

**UNIT-4: Basics of Electronics**

Semiconductors-Junction diode-Zener diode-LED- Transistor-configurations – diode half wave and full wave rectifier -Regulated power supply using Zener diode-Transistor amplifier

**UNIT-5: Electronics Appliances**

Scientific Calculators, Personal computer-Lap Top-Smart Phones- Laser Printer-Color TV-OLED-QLED TV-Refrigerator-Washing Machine – Function – Types – Semi and Fully Automatic-Top and Front loading-washing technique-Air Conditioner, Microwave Oven-Principle and Design

## **Text Books**

### **Unit-1 to Unit-4**

1. B L Theraja , A text book in Electrical Technology,S. Chand & Co., New Delhi, 2013
2. V K Metha , Principles of Electronics by, S. Chand & Co., 2001.
3. R.S Sedha, A Text Book of Digital Electronics, S.Chand&CO.Ltd., New Delhi,2010
4. Performance and design of AC machines – M G Say ElBSEdn.

### **Unit-5**

1. S.P Bali, Consumer Electronics, Pearson, 2004

## **Reference Books**

1. Bagde and Singh, Elements of Electronics, S. Chand & Co., New Delhi, 2000.
2. Gulati, Monochrome and Colour TV,New Age International (P) limited, Publishers, New Delhi, 2005
3. Mitchel Schultz, Grob'sBasic Electronics,McGraw Hill NY ,2010.

## **E-Materials**

1. <https://www.allaboutcircuits.com/textbook/reference/chpt-2/resistor-color-codes/>
2. <https://www.youtube.com/watch?v=SjlnW5g9np4>
3. <https://circuitglobe.com/difference-between-single-phase-and-three-phase.html>
4. [https://www.youtube.com/watch?v=r\\_DGW3OrPVg](https://www.youtube.com/watch?v=r_DGW3OrPVg)
5. <https://www.youtube.com/watch?v=NNkoAJkXUAW>
6. <https://www.slideshare.net/ideseditor/533-28626238>
7. <https://en.wikipedia.org/wiki/Semiconductor>
8. [https://www.youtube.com/watch?v=CjAVfW\\_6juw](https://www.youtube.com/watch?v=CjAVfW_6juw)
9. <https://www.youtube.com/watch?v=7HiNABH1kYE>
10. <https://mrwashingmachine.in/working-principle-of-washing-machine/>

## **Course Outcomes**

1. After studied unit-1, the student will be able to identify the given discrete components like resistors using color coding method.
2. After studied unit-2, the student will be able to understand the theory of household electrical connections.
3. After studied unit-3, the student will be able to know the principle and working of some household electrical appliances.
4. After studied unit-4, the student will be able to acquire knowledge about theory of semiconductors.
5. After studied unit-5, the student will be able to know the principle and working of some household electronics appliances.

**OPEN ELECTIVE  
PAPER -3**

**B. PHYSICS OF MATERIALS**

Course Objectives

1. To teach the basics of bonding in crystals
2. Students can learn the diffraction of X-Rays by crystals
3. To expose the classical and quantum free electron theory of metals
4. To discuss the theory of different energy bands in solids
5. To explain the introduction and properties of superconductors

**Unit-1: Crystals**

Basic concepts-Symmetry elements-Bravais Lattice-Miller Indices-Basic definitions of crystal structure-BCC and Cesium chloride structure-Bonding in solids: Types of bonds in crystals - Ionic, Covalent, Metallic, Molecular and Hydrogen bonds.

**UNIT-2: Diffraction of X-Rays by crystals**

X-ray diffraction: Derivation of Bragg's law - Bragg spectrometer -Determination of interatomic distance-Determination of interplanar distance-Interpretation of X-ray diffraction pattern - Laue's, Rotating crystal and Powder methods.

**UNIT-3: Conductors**

Classical free electron theory- Expression for electrical conductivity-Verification of Ohm's law-Thermal conductivity- Expression for thermal conductivity-Wiedmann-Franz law and Lorentz number- Quantum free electron theory of metals

**UNIT-4: Semiconductors**

Energy bands in solids: Classification of solids on the basis of energy band theory - Semiconductors- n type and p type semiconductors - Fermi level in intrinsic semiconductor-Electrical conductivity-Determination of band gap-Hall effect-Determination of Hall coefficient

**UNIT-5: Superconductors**

Introduction-Properties of superconductors-Meissner effect-Types of Superconductors-Type I and Type II-BCS theory of superconductivity-Cooper pair-Josephson Effect-Applications.

**Text Book**

**Unit 1 to Unit 5**

K. Ilangoan, Solid State Physics, S. Viswanathan, Printers & Publishers Private Ltd, Chennai, 2007

## Reference Books

1. S.O. Pillai, Solid State Physics, New Age International Publishers, 2015.
2. C. Kittel, Introduction to Solid State Physics, Wiley Eastern Limited, 2005.
3. Saxena, Gupta & Saxena, Fundamentals of Solid State Physics, PragatiPrakashan, Meerut, 2015.

## E-Materials

1. [https://en.wikipedia.org/wiki/Crystal\\_structure](https://en.wikipedia.org/wiki/Crystal_structure)
2. <https://byjus.com/chemistry/crystal-structure/>
3. [https://en.wikipedia.org/wiki/Bragg%27s\\_law](https://en.wikipedia.org/wiki/Bragg%27s_law)
4. [https://www.youtube.com/watch?v=8Gma\\_FfCl2A](https://www.youtube.com/watch?v=8Gma_FfCl2A)
5. <https://www.youtube.com/watch?v=vMZOYpOUGZ8>
6. <http://en2k6.blogspot.com/2008/02/free-electron-theory.html>
7. <https://vlab.amrita.edu/?sub=1&brch=282&sim=879&cnt=1>
8. <https://www.youtube.com/watch?v=AwjBHzwWLo>
9. <https://www.youtube.com/watch?v=Vqx21iqQ7cI>
10. [https://en.wikipedia.org/wiki/Meissner\\_effect](https://en.wikipedia.org/wiki/Meissner_effect)

## Course Outcomes

1. After studied unit-1, the student will be able to learn the basics of crystal structure and various types of bond exists in the crystals
2. After studied unit-2, the student will be able to know the statement of Bragg's law and to study the Diffraction of X-ray by different methods
3. After studied unit-3, the student will be able to understand the classical and quantum theory of free electrons in metals
4. After studied unit-4, the student will be able to distinguish between intrinsic and extrinsic semiconductor and can determine the Hall coefficient of a material
5. After studied unit-5, the student will be able to describe the properties of superconductors and hence the students can distinguish Type I and Type II superconductors



**OPEN ELECTIVE  
PAPER - 3**

**C. GEOPHYSICS**

**Course Objectives**

The aim of the course is to understand physical properties of Earth through Physics principles

1. To learn the different concepts related to the earth
2. Study of earth with geophysical and geochemical methods
3. To give an introduction about seismology
4. To study the properties of earth with reference to magnetic field
5. To inculcate knowledge on radioactivity of earth and its thermal properties

**Unit 1: Physics of the Earth**

Introduction to Geophysics- Earth as a member of the solarsystem-Atmosphere-Ionosphere-Asthenosphere-Lithosphere-Hydrosphere and Biosphere-Meteorology-Oceanography andHydrology.

**Unit 2: Geophysical and Geochemical methods**

Geophysical methods: Geo referencing using Arc GIS software-Electrical methods-Qualitative interpretation of VerticalElectrical Sounding curves –Preparing pseudo cross section forelectrical resistivity data and interpretation

Geochemical methods: Introduction-Principles of groundwaterchemistry-Sources of contamination- Ground water qualityanalysis.

**Unit 3: Introduction to Seismology**

The earth's interior and crust as revealed by earthquakes-Rayleigh waves and Love waves-Elastic rebound theory-Continental drift-Earthquake magnitude and intensity-Horizontal seismograph and seismograph equation-Tsunami-Causes andImpacts-Tsunami warning systems.

**Unit 4: Geomagnetism and Gravity**

Historical introduction –The physical origin of magnetism-Causes of the main field-Dynamo theory of earth's magnetism-Gravitational potential-Laplace's equation and Poisson'sequation-Absolute and relative measurements of gravity-Worden gravimeter.

**Unit 5: Geochronology and Geothermal physics**

Radioactivity of the earth-Radioactive dating of rocks andminerals-Geological time scale-The age of the earth-Flow of heat to the surface of the earth –Sources of heat withinthe earth-Process and heat transport and internal temperature ofearth.

### **Text Books**

1. Cook,A.H , Physics of the Earth and Planets, McMillanPress,London,1973.
2. Arthur W.Hounslow, Water quality data -Analysis and,Interpretation, Lewis publishers, Washington D.C.1995
3. G.P.Mahapatra,. Physical Geology,CBSPublishers,New Delhi,1994.

### **Reference Books**

1. Garland, Introduction to Geophysics 11 edition, WBSaunder Company, London, 1979.
2. William Lowrie, Fundamentals of Geophysics, 11Edition, Cambridge press,UK.
3. Nils-Axel Morne, Geochronology-Methods and casestudies, INTECH publications .
4. John Raferty, Geochronology –Dating and Precambriantime –The beginning of the world as we know it,Britannica Educational publishers, New York-2011.
5. Don L.Anderson, Theory of the Earth, Blackwellscientific Publications-UK, 1979

### **E-Materials**

1. [https://en.wikipedia.org/wiki/Earth\\_science](https://en.wikipedia.org/wiki/Earth_science)
2. <https://en.wikipedia.org/wiki/Earth>
3. [https://www.youtube.com/watch?v=JGXi\\_9A\\_Vc](https://www.youtube.com/watch?v=JGXi_9A_Vc)
4. <https://www.youtube.com/watch?v=-ZFmAAHBfOU>
5. <https://mangomap.com/gis-software>
6. <https://en.wikipedia.org/wiki/Earthquake>
7. <https://www.youtube.com/watch?v=GQOCvsxHtJo>
8. <https://www.youtube.com/watch?v=fQt6UaR8Fcw>
9. <https://en.wikipedia.org/wiki/Gravimeter>
10. [https://www.radioactivity.eu.com/site/pages/Earth\\_Heat.htm](https://www.radioactivity.eu.com/site/pages/Earth_Heat.htm)
11. [https://www.youtube.com/watch?v=46MN\\_okpKbQ](https://www.youtube.com/watch?v=46MN_okpKbQ)

### **Course Outcomes**

1. After studied unit-1, the student will be able to explain about solar system and atmosphere, ionosphere etc.
2. After studied unit-2, the student will be able to demonstrate geo referencing using GIS software and to test the contamination of ground water using geochemical method.
3. After studied unit-3, the student will be able to describe about earthquakes and natural disaster Tsunami and its impacts
4. After studied unit-4, the student will be able to learn about the earth in the presence of magnetic field and gravity
5. After studied unit-5, the student will be able to know the radioactivity of the earth, can calculate the radioactive dating of rocks and minerals and thermal properties of the earth.

## SEMESTER IV

### PAPER - 10

## SPECTROSCOPY

### Course Objectives

1. To give an idea about rotational spectra of different molecules using rotational spectroscopy
2. To study the vibrational spectroscopy of diatomic and polyatomic molecules using Infrared spectroscopy
3. To acquire knowledge on Raman spectroscopy and its applications.
4. To expose the concept of Ultra Violet spectroscopy and its applications
5. Students can learn the theory and applications of NMR ,ESR, AAS and Mössbauerspectroscopy.

### UNIT-1: Rotational (Microwave) Spectroscopy

Classification of molecules-Interaction of radiation with rotating molecule- Rotational spectra of Rigid –Isotope effect in rotational spectra- Intensity of rotational lines-Non-rigid rotator-Linear polyatomicmolecules- Symmetric and asymmetric top molecules-Stark effect-QuadrupoleHyperfine Interaction-Microwave spectrometer Instrumentation-Applications..

### UNIT-2: Infrared spectroscopy

Introduction- Vibrational energy of a diatomic molecule-Vibrating diatomic molecule-Diatomic vibrating rotator-Vibrations of polyatomic molecules-Normal modes of molecular vibrations- Normal mode vibrations of CO<sub>2</sub> and H<sub>2</sub>O molecules-Dipole moment change in CO<sub>2</sub> molecule-Hydrogen bonding-Interpretation of vibrational spectra-Instrumentation of IR spectrometer-FTIR spectroscopy-Principle, Instrumentation, sample handling techniques and applications-ATR Technique.

### UNIT-3: Raman Spectroscopy

Classical theory of Raman Scattering - Quantum theory of Raman effect-Rotational, Vibrational Raman spectra of molecules; Structure determination using IR and Raman spectroscopy-Instrumentation of Raman spectrometer-Coherent anti-Stokes Raman Spectroscopy - Surfaces for SERS study – Enhancement mechanism – Instrumentation and sampling techniques - FT Raman Spectroscopy: Principle, Instrumentation, sample handling techniques and applications.

### UNIT-4: UV Spectroscopy

Energy levels-Molecular orbitals-Theory of UV (electronic) spectra-Franck Condon Principle -transition Probability, measurement of spectrum – Types of transition in Organic molecules -

Types of absorption bands – transition in metal complexes – Selection rules Chromophore concept – Applications of UV Spectroscopy.

### **UNIT-V: NMR, ESR, AAS and Mössbauer Spectroscopy**

Magnetic properties of nuclei-Resonance Condition-NMR instrumentation-Relaxation Process--Bloch equations - Chemical shifts –NMR Imaging.

Introduction-Principle of ESR - ESR spectrometer-Hyperfine Structure- ESR spectrum of Hydrogen.

Atomic Absorption Spectroscopy (AAS): Principle of AAS-single beam Spectrophotometer - Applications of AAS.

Mössbauer Effect - Recoilless emission and absorption - Mossbauer spectrum -Experimental methods - Mossbauer spectrometer-Applications.

### **Text Books**

#### **Unit 1 to Unit 3 and Unit 5**

1. G. Aruldas, 2001, Molecular Structure and Spectroscopy, Prentice - Hall of India Pvt.Ltd., New Delhi.

#### **Unit 4**

1. H. Kaur, Spectroscopy, PragatiPrakashan, Meerut, 2017.

### **Reference Books**

1. Colin Banwell, Elaine M. McCash, Fundamentals of Molecular Spectroscopy:, TMH publishers, 2013.
2. D.N. Satyanarayana, Vibrational Spectroscopy and Applications, New Age International Publications, New Delhi, 2004.
3. G.R.Chatwal and S.K.Anand, Spectroscopy (Atomic & Molecular), Himalaya Publishing House, 2016

### **E-Materials**

1. [https://en.wikipedia.org/wiki/Microwave\\_spectroscopy](https://en.wikipedia.org/wiki/Microwave_spectroscopy)
2. <https://www.youtube.com/watch?v=3-8nAn0Mo6w>
3. [https://en.wikipedia.org/wiki/Vibrational\\_spectroscopy\\_of\\_linear\\_molecules](https://en.wikipedia.org/wiki/Vibrational_spectroscopy_of_linear_molecules)
4. <https://www.youtube.com/watch?v=58wqjy-ALLg>
5. [https://en.wikipedia.org/wiki/Attenuated\\_total\\_reflectance](https://en.wikipedia.org/wiki/Attenuated_total_reflectance)
6. <https://www.youtube.com/watch?v=q0evGXCK-sY>
7. <https://www.youtube.com/watch?v=paZS5gv3P8g>
8. [https://en.wikipedia.org/wiki/Raman\\_spectroscopy](https://en.wikipedia.org/wiki/Raman_spectroscopy)
9. <https://nptel.ac.in/content/storage2/courses/115101003/downloads/module3/lecture30.pdf>
10. [https://www.youtube.com/watch?v=-76hr\\_97m10](https://www.youtube.com/watch?v=-76hr_97m10): [https://en.wikipedia.org/wiki/Franck%E2%80%93Condon\\_principle](https://en.wikipedia.org/wiki/Franck%E2%80%93Condon_principle)
11. <https://nptel.ac.in/courses/104108078/>

12. <https://www.vanderbilt.edu/AnS/Chemistry/Rizzo/chem220a/Ch13slides.pdf>
13. [https://en.wikipedia.org/wiki/Electron\\_paramagnetic\\_resonance](https://en.wikipedia.org/wiki/Electron_paramagnetic_resonance)

### **Course Outcomes**

1. After studied unit-1, the student will be able to study the rotational spectra of diatomic and polyatomic molecules using rotational/ microwave spectroscopy.
2. After studied unit-2, the student will be able to distinguish between the rigid rotator and non-rigid rotator and students can calculate normal modes of vibrations for H<sub>2</sub>O and N<sub>2</sub>O molecules.
3. After studied unit-3, the student will be able to derive the expression for classical and quantum theory of Raman effect and also to study the molecular structure of water and CO<sub>2</sub> molecules.
4. After studied unit-4, the student will be able to understand the qualitative idea of UV-spectroscopy and also to learn the electronic spectra of poly atomic molecules.
5. After studied unit-5, the student will be able to know qualitatively the principle, theory, instrumentation and applications of NMR, ESR, AAS and Mössbauer spectroscopy.

**CORE ELECTIVE  
PAPER -4  
(to choose 1 out of 3)**

**A. CRYSTAL GROWTH AND THIN FILMS**

**Course Objectives**

1. To introduce theories of crystal growth.
2. To teach the various mechanisms of crystal growth.
3. To study the crystal symmetry and crystal structures.
4. To know the basics of thin film deposition techniques.
5. To learn the different characterization techniques.

**UNIT-1: Theories of Crystal Growth**

Introduction to crystal growth – Solubility – Saturation – Supersaturation – Induction Time - nucleation – Metastable Zone width – Gibbs - Thomson equation - kinetic theory of nucleation – Classical Nucleation Theory - homogeneous and heterogeneous nucleation – different shapes of nuclei – spherical, cap, cylindrical and orthorhombic – Temkins model – BCF theory.

**UNIT -2: Crystal growth Techniques**

Crystal Growth Mechanisms – Solid phase – Liquid Phase and Gas Phase crystal growth - Bridgman technique - Czochralski method – Skull Melting process - Verneuil technique - zone melting – Floating Zone method - gel growth – solution growth methods – low and high temperature solution growth methods – HTSG Flux growth – vapour growth - epitaxial growth techniques - LPE – MOCVD – MBE – Deposition Techniques – PVD – CVD- Sputtering – Ion Implantation – Gel growth – Hydrothermal Growth

**UNIT-3: Crystal symmetry and Structures**

Symmetry operations, elements - translational symmetries - point groups - space groups - equivalent positions – close packed structures - voids - important crystal structures – Pauling's rules - defects in crystals – Amorphous - polymorphism and twinning.

**UNIT-4: Thin Film deposition Techniques**

Thin Films – Basic of Thin films and Nanostructures - Role of thin films in Devices - Sol-gel synthesis - Spin coating – Chemical Bath Deposition – Electro Deposition - Chemical Bath Deposition - Physical Methods – Resistive Heating - Electron Beam Gun - Laser Gun-Spray pyrolysis- Evaporation and Flash Evaporations - Sputtering - Reactive Sputtering, Radio-Frequency Sputtering - ion implantation - Cathodic arc deposition - Pulsed laser deposition – Molecular beam epitaxy - Introduction to Vacuum Technology - Deposition Techniques - Films and artificial superstructures.

**UNIT-5: Characterization Techniques**

X – Ray Diffraction (XRD) – Powder and single crystal – Laue pattern – Spectrometry - UV-Vis-NIR Spectrometer - IR spectroscopy - Fourier transform Infrared analysis (FT-IR) – Elemental analysis – NMR: Nuclear Magnetic Resonance – ESR: Electron Spin Resonance – EPR: Electron Paramagnetic Resonance - Elemental dispersive X-ray analysis (EDAX) - Scanning Electron Microscopy (SEM) – Transmission Electron Microscopy (TEM) – Atomic Force Microscopy (AFM) – Luminescence Studies – Thermo Luminescence – Photo Luminescence — Etching Studies (Chemical) – Micro hardness tests – Vickers – Brinells - Micro hardness – TGA-DTA studies - Dielectric studies – Harmonic generation tests – SHG-higher generation tests.

### **Text Books**

#### **Unit 1 to Unit 3**

1. H.E.Buckley. Crystal growth. John Wiley & sons, New York, 1981.
2. P.Ramasamy and P.Santhanaraghavan. Crystal growth processes and methods. KRUPublications, 2000.

#### **Unit 4**

1. A.Goswami, Thin Film Fundamentals, New Age International (P) Limited, New Delhi, 1996.

### **Reference Books**

1. J.C. Brice, Crystal Growth Processes, John Wiley and Sons, New York (1986)
2. S.O.Pillai, Solid State Physics, New Age International Publishers, 2016.
3. D.Elwell and H.J.Scheel. Crystal growth from high temperature solution. Academic Press, New York, 1995.
4. R.A.Laudise. The growth of single crystals. Prentice Hall, Englewood, 1970.
5. L.V.Azaroff. Elements of X-ray crystallography. Techbooks, 1992.
6. J.A.K.Tareen and T.R.N.Kutty. A Basic course in Crystallography. University Press, 2001.
7. C.Hammond. The Basics of Crystallography and Diffraction, IUCr-Oxford University Press, 2009.
8. H.H. Willard, L.L. Meritt, J.A. Dean, F.A. Sette, Instrumental Methods of
9. Analysis, CBS Publishers, New Delhi, 1986.
10. S. Zhang, L. Li and A. Kumar, Materials Characterization Techniques (CRC Press, BocaRaton, 2009).
11. J.C. Brice, Crystal Growth Process (John Wiley, New York, 1986).
12. M. Ohring, Materials Science of Thin Films (Academic Press, Boston, 2002) 2nd edition.
13. E. N. Kaufmann, Characterization of Materials, Volume-I, John Wiley, New Jersey, 2012.

### **E-Materials**

1. <http://14.139.186.108/jspui/bitstream/123456789/16020/1/Chapter%20I%20to%20XI.pdf>
2. [https://www.youtube.com/watch?v=G76H7A6\\_iyo](https://www.youtube.com/watch?v=G76H7A6_iyo)
3. <https://www.slideshare.net/SHASHISHAW1/crystal-growth-techniques>
4. [https://shodhganga.inflibnet.ac.in/bitstream/10603/364/9/09\\_chapter%202.pdf](https://shodhganga.inflibnet.ac.in/bitstream/10603/364/9/09_chapter%202.pdf)
5. <https://www.slideshare.net/AvinashAvi110/crystal-stmmetry>
6. <https://slideplayer.com/slide/4199534/>
7. <https://www.youtube.com/watch?v=ZBf46mqRGf0>
8. [https://shodhganga.inflibnet.ac.in/bitstream/10603/136917/10/10\\_chapter%203.pdf](https://shodhganga.inflibnet.ac.in/bitstream/10603/136917/10/10_chapter%203.pdf)
9. [https://en.wikipedia.org/wiki/Transmission\\_electron\\_microscopy](https://en.wikipedia.org/wiki/Transmission_electron_microscopy)
10. <https://www.youtube.com/watch?v=BbBK4T5Yr3M>

### **Course Outcomes**

1. After studied unit-1, the student will be able to learn the different theories of crystal growth and able to formulate Gibbs - Thomson equation.
2. After studied unit-2, the student will be able to demonstrate the Bridgman technique, Czochralskimethod ,Skull Melting process etc. of crystal growth.
3. After studied unit-3, the student will be able to understand the symmetry operations, elements, point groups, space groups and defects in crystals.
4. After studied unit-4, the student will be able to explain the basics of thin film deposition techniques like, spin coating, chemical bath deposition, spray pyrolysis etc.
5. After studied unit-5, the student will be able to know the principle, working and applications of different characterization techniques.

### **CORE ELECTIVE PAPER -4**



## **B. MEDICAL PHYSICS**

### **Course Objectives**

This paper provides a broad knowledge on the

1. Interaction of Non-Ionizing Radiation
2. Applications of Laser in Medicine
3. Ultrasound in tissues and their use in medicine.
4. Medical Ultrasound Applications
5. Radio frequency and Microwaves

### **UNIT-1: Review of non-ionising Radiation Physics in Medicine**

Different sources of Non Ionising radiation-their physical; properties-first law of photochemistry- Law of reciprocity- - Electrical Impedance and Biological Impedance - Principle and theory of thermography – applications.

### **UNIT-2: Tissue Optics**

Various types of optical radiations - UV, visible and IR sources - Lasers: Theory and mechanism-Laser Surgical Systems-Measurement of fluence from optical sources - Optical properties of tissues – theory and experimental techniques-interaction of laser radiation with tissues –photothermal -photochemical – photoablation – electromechanical effect.

### **UNIT-3: Mediphotonics**

Lasers in dermatology, oncology and cell biology - Application of ultrafast pulsed lasers in medicine and biology-Lasers in blood flow measurement - Fiber optics in medicine - microscopy in medicine - birefringence - Fluorescence microscope - confocal microscope - Hazards of lasers and their safety measures.

### **UNIT-4: Medical Ultrasound**

Production, properties and propagation of ultrasonic waves- Bioacoustics – Acoustical characteristics of human body- Ultrasonic Dosimetry - Destructive and nondestructive tests - Cavitation - Piezo electric receivers, thermoelectric probe – Lithotropy - High power ultrasound in therapy

### **UNIT-5: Radio Frequency and Microwaves**

Production and properties - interaction mechanism of RF and microwaves with biological systems: Thermal and non-thermal effects on whole body, lens and cardiovascular systems – tissue characterization and Hyperthermia and other applications-Biomagnetism - Effects - applications.

### **Text Books**

#### **Unit-1**

1. S. S Martellucci and A. N. Chester, Laser Photobiology and Photomedicine, Plenum Press, New York, 1985.

### **Unit-2**

1. Markolf H. Neimz, Laser-Tissue Interactions, Springer Verlag, Germany, 1996.

### **Unit-3 to Unit-5**

1. S. S Martellucci and A. N. Chester, Laser Photobiology and Photomedicine, Plenum Press, New York, 1985.

### **.Reference Books**

1. J. R. Greening, Medical Physics, North Holland Publishing Co., New York, 1999.
2. R. Pratesi and C. A. Sacchi, Lasers in Photomedicine and Photobiology, Springer Verlag, West Germany, 1980.
3. Harry Moseley, Hospital Physicists' Association, Non-ionising radiation: microwaves, ultraviolet, and laser radiation, A. Hilger, in collaboration with the Hospital Physicists, Association, 1988

### **E-Materials**

1. [https://www.youtube.com/watch?v=9TCK1Sa0\\_Vc](https://www.youtube.com/watch?v=9TCK1Sa0_Vc)
2. <https://en.wikipedia.org/wiki/Thermography>
3. [https://en.wikipedia.org/wiki/Laser\\_surgery](https://en.wikipedia.org/wiki/Laser_surgery)
4. <https://www.indiamart.com/proddetail/co2-laser-surgical-system-3595170512.html>
5. <https://ilchiro.org/laser-safety-for-clinical-applications/>
6. [https://en.wikipedia.org/wiki/Laser\\_safety](https://en.wikipedia.org/wiki/Laser_safety)
7. <https://grantome.com/grant/NIH/R01-HD021687-06>
8. <https://www.frontiersin.org/articles/10.3389/fbioe.2020.00025/full>
9. <https://www.youtube.com/watch?v=CY4roB9ZTEo>
10. <https://en.wikipedia.org/wiki/Biomagnetism>

### **Course Outcomes**

1. After studied unit-1, the student will be able to study the different sources of non-ionizing radiations.
2. After studied unit-2, the student will be able to know the various types of optical radiations like UV, IR etc.
3. After studied unit-3, the student will be able to explain the laser and fiber optic instruments for mediphotonics.
4. After studied unit-4, the student will be able to learn the properties and propagation of ultrasonic waves and also able to know the ultrasonic dosimetry.
5. After studied unit-5, the student will be able to understand the applications of radio frequency and microwaves.

## **CORE ELECTIVE PAPER -4**

## **C. MATLAB AND PYTHON PROGRAMMING**

### **Course Objectives**

1. To give an basic concepts of MATLAB
2. To teach the BODMAS rules and mathematical operations
3. To expose the fundamentals of Python programming
4. To learn the structured types, mutability and higher-order functions
5. To conceptualize the TKinter modules

### **UNIT-1: Introduction on MATLAB**

Introduction-Use of MATLAB-Introduction to MATLAB software-MATLAB window-Command window-workspace-Command history-Setting Directory-Working with the MATLAB user interface-Basic Commands-Assigning variables-Operations with variables-Character and string-Arrays and vectors-Column vectors-Row vectors.

### **UNIT-2: Mathematical Operations**

BODMAS rules-Arithmetic operations-Operators and special characters-Mathematical and logical operators-Creating rows and columns matrix-Matrix operations-Transpose-Determinant-Inverse-Solving Matrix-Plots-2D plots-3D Plots.

### **UNIT-3: Basics of Python**

The basic elements of python (Software, Development Tools, Programming with Python, writing a Python Program, Python Interactive Shell, Values and Variables, Expressions) - Branching Programs - Control Structures – Strings and Input – Iteration - Functions and scoping – Specifications – Recursion- Global variables – Modules – Files - System - Functions and Parameters – simple programs.

### **UNIT-4: Structured Types, Mutability and Higher-order Functions**

Strings, Tuples, Lists and Dictionaries - Lists and Mutability - Functions as Objects – extrapolation, de'slanders table, – Classes and Object-Oriented Programming – programs

### **UNIT-5: TKinter**

TKinter modules -Tkinter classes - Tkinter widgets: button, canvas, frame, listbox, messagebox - widget configuration – widget styles – events and bindings - standard dialogs – GUI programs

### **Text Books**

#### **Unit 1**

1. Amos Gilat, MATLAB an Introduction with Applications, John Wiley & Sons, INC Publication, 2004

#### **Unit 2 to Unit 4**

1. John V Guttag. "Introduction to Computation and Programming Using Python", Prentice Hall of India 2013

#### **Unit 5**

1. Tkinter manual

#### **Reference Books**

1. MATLAB 7.0 Basics, P. Howard, spring, 2005.
2. R. NageswaraRao, "Core Python Programming", dreamtech
3. Wesley J. Chun. "Core Python Programming - Second Edition", Prentice Hall
4. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, "Data Structures and Algorithms in Python", Wiley
5. Kenneth A. Lambert, "Fundamentals of Python – First Programs", CENGAGE Publication

#### **E-Materials**

1. <https://www.tutorialspoint.com/matlab/index.htm>[www.mathworks.com/products/matlab.html](http://www.mathworks.com/products/matlab.html)
2. [http://mayankagr.in/images/matlab\\_tutorial.pdf](http://mayankagr.in/images/matlab_tutorial.pdf)
3. <https://www.mccormick.northwestern.edu/documents/students/undergraduate/introduction-to-matlab.pdf>
4. <https://www.mathworks.com/videos/introduction-to-matlab-81592.html>
5. <https://www.youtube.com/watch?v=uQrJ0TkZlc>
6. <https://www.youtube.com/watch?v=rfscVS0vtbw>
7. <https://www.youtube.com/watch?v=Y8Tko2YC5hA>
8. <https://www.programiz.com/python-programming>
9. [https://www.w3schools.com/python/python\\_intro.asp](https://www.w3schools.com/python/python_intro.asp)
10. [https://www.tutorialspoint.com/python/python\\_gui\\_programming.htm](https://www.tutorialspoint.com/python/python_gui_programming.htm)
11. <https://likegeeks.com/python-gui-examples-tkinter-tutorial/>

#### **Course Outcomes**

1. After studied unit-1, the student will be able to understand the basics of MATLAB

2. After studied unit-2, the student will be able to develop skills for writing a program using MATLAB
3. After studied unit-3, the student will be able to learn the fundamentals of Python programming
4. After studied unit-4, the student will be able to know the concepts of OOPs in Python
5. After studied unit-5, the student will be able to learn how to develop graphical user interfaces by writing some Python GUI examples using Tkinter package.

**OPEN ELECTIVE  
PAPER-4  
(to choose 1 out of 3)**

**A. NANOPHYSICS**

**Course Objectives**

1. To know the fundamentals of nanotechnology.
2. To learn about carbon nanostructures and its properties.
3. To study the preparation of nanomaterial by different methods.
4. To analyse the synthesized nanomaterial by various characterization techniques.
5. To understand the various applications of nanotechnology.

**UNIT-1: Introduction to Nano and Types of Nanomaterial**

Need and origin of nano - Emergence of nanotechnology with special reference to Feynman. Size & Scales: definition of nanostructures; Top-down and bottom-up approaches – Introductory ideas of 1D, 2D and 3D nanostructured material– Quantum dots -- Quantum wire – Quantum well -- Exciton confinement in quantum dots.

**UNIT-2: Carbon Nanostructures**

Carbon molecules and carbon bond-C60: Discovery and structure of C60 and its crystal - Superconductivity in C60-Carbon nanotubes: Fabrication - Structure-Electrical properties – Vibrational properties -Mechanical properties – Applications(fuel cells, chemical sensors, catalysts).

**UNIT-3: Fabrication of Nanomaterial**

Synthesis of oxide nanoparticles by sol-gel method -Electrochemical deposition method- Electrospinning method –Lithography-Atomic layer deposition-Langmuir--Blodgett films - Zeolite cages -- Core shell structures – Organic and inorganic hybrids.

**UNIT-4: Characterization of Nanomaterial**

Principles, experimental set-up, procedure and utility of scanning electron microscopy (SEM), transmission electron microscopy (TEM), scanning tunneling microscope (STM) and scanning probe microscopy (SPM).

**UNIT-5: Applications**

Molecular electronics and nanoelectronics -Nanorobots -Biological applications of nanoparticles -Catalysis by gold nanoparticles-Band-gap engineered quantum devices- Nanomechanics - CNT emitters- Photoelectrochemical cells-Photonic crystals -Plasmon waveguides.

## **Text Books**

### **Unit 1 to Unit 5**

1. T.Pradeep et al., A Textbook of Nanoscience and Nanotechnology, Tata McGraw Hill, New Delhi, 2012.
2. T.Pradeep , Nano: The Essentials, Tata McGraw Hill, New Delhi, 2012.
3. R.W. Kelsall, I.W. Hamley and M. Geoghegan, Nanoscale Science and
4. Nanotechnology (John-Wiley & Sons, Chichester, 2005.
5. G. Cao, Nanostructures and Nanomaterials, Imperial College Press, London, 2004.
6. C.P. Poole and F.J. Owens, Introduction to Nanotechnology, Wiley, New Delhi, 2003.

## **Reference Books**

1. H.S. Nalwa, Nanostructured Materials and Nanotechnology, Academic Press, San Diego, 2002.
2. M. Wilson, K. Kannagara, G. Smith, M. Simmons, B. Raguse, Nanotechnology: Basic Science and Emerging Technologies, Overseas Press, New Delhi, 2005.

## **E-Materials**

1. <https://en.wikipedia.org/wiki/Nanotechnology>
2. [https://en.wikipedia.org/wiki/Carbon\\_nanotube](https://en.wikipedia.org/wiki/Carbon_nanotube)
3. [https://www.nanowerk.com/nanotechnology/introduction/introduction\\_to\\_nanotechnology\\_22.php](https://www.nanowerk.com/nanotechnology/introduction/introduction_to_nanotechnology_22.php)
4. <https://www.youtube.com/watch?v=sbuIluJhT4A>
5. <https://www.youtube.com/watch?v=14DqBIG96W0>
6. <https://www.sciencedirect.com/topics/chemistry/sol-gel-process>
7. <https://www.slideshare.net/RamalingamGopal/sol-gel-synthesis-of-nanoparticles>
8. [https://en.wikipedia.org/wiki/Scanning\\_electron\\_microscope](https://en.wikipedia.org/wiki/Scanning_electron_microscope)
9. <https://www.youtube.com/watch?v=kdb6dHEHCA0>
10. <https://interestingengineering.com/15-medical-robots-that-are-changing-the-world>
11. <https://en.wikipedia.org/wiki/Nanorobotics>

**OPEN ELECTIVE  
PAPER-4**

**B. ASTRO PHYSICS**

**Course Objectives**

1. To acquire the knowledge of astronomical instruments
2. To understand the basic ideas of space
3. To learn about the birth of stars, color, age etc.
4. To study the complete details of our solar system
5. To gain the knowledge on celestial measurements

**UNIT -1: Astronomical Instruments**

Optical telescope - reflecting telescope - types of reflecting telescope - advantages of reflecting telescopes - radio telescope - astronomical spectrographs - photographic photometry - photoelectric spectrometry- detectors and image processing.

**UNIT-2: Space**

Introduction – Hubble’s Law – Big bang theory – Shape of Universe – Expanding universe in space – Galaxies – Types of Galaxies – Spiral, Elliptical and Irregular Galaxies – Clusters of Galaxies – Milky Way – Quasars.

**UNIT -3 : Stars**

Birth of Stars – Colour and Age – Life of Stars – Red giant stars – White dwarf star – Neutron Star – Black hole – Supernovae – Constellations - Zodiac.

**UNIT -4: Solar system**

Introduction – Sun – Structure of Sun – Nuclear reactions in sun – Sun spot and solar flares – Earth – Structure of earth – Atmosphere – Moon and its structure – Inner planets – Outer planets – Asteroids – Meteors – Meteorites - Comets.

**UNIT-5 :Space distance, Units and Co-ordinates**

Cislunar space -Translunar space-Inter planetary distance -Interstellar space -Inter galactic space-Light Year- Astronomical Unit-Astronomical Map. Astronomical Systems - Astronomical co-ordinates -Celestial Sphere -Celestial Equators – Celestial Poles.

**Text Books**

1. BaidyanathBasu, An introduction to Astrophysics, Prentice Hall of India Private limited New Delhi, 2001.
2. A.Hewish., Physics of the Universe, CSIR publication, New Delhi, 1992.



## Reference Books

1. BimanBasu, Inside Stars, CSIR Publication, New Delhi, 1992.
2. BimanBasu, Cosmic Vistas, National Book Trust of India, 2002.
3. K.S. Krishnasamy, Astro Physics a Modern Perspective, New Age International ,New Delhi.
4. R. Murugesan and KiruthigaSivaprasath, Modern Physics, S.Chand&Co.Pvt.Ltd, 2016.
5. Mohan SundaraRajan, Space Today, National Book Trust of India, 2000.

## E-Materials

1. <http://www.phy.olemiss.edu/~perera/astr325/Lec23.pdf>
2. [https://en.wikipedia.org/wiki/List\\_of\\_astronomical\\_instruments](https://en.wikipedia.org/wiki/List_of_astronomical_instruments)
3. <https://www.youtube.com/watch?v=O0HyEEkckR0>
4. <https://www.youtube.com/watch?v=5bYNIY7m03w>
5. [https://en.wikipedia.org/wiki/The\\_Big\\_Bang\\_Theory](https://en.wikipedia.org/wiki/The_Big_Bang_Theory)
6. <https://en.wikipedia.org/wiki/Galaxy>
7. <https://www.youtube.com/watch?v=BcjmoEspoRI>
8. <https://www.youtube.com/watch?v=ZrS3Ye8p61Y>
9. <https://en.wikipedia.org/wiki/Star>
10. [https://en.wikipedia.org/wiki/Solar\\_System](https://en.wikipedia.org/wiki/Solar_System)
11. [https://www.youtube.com/watch?v=KsF\\_hdjWJjo](https://www.youtube.com/watch?v=KsF_hdjWJjo)
12. <https://www.youtube.com/watch?v=1Toya19H12w>
13. [https://en.wikipedia.org/wiki/Celestial\\_sphere](https://en.wikipedia.org/wiki/Celestial_sphere)

## Course Outcomes

1. After studied unit-1, the student will be able to know the principle and working of astronomical instruments.
2. After studied unit-2, the student will be able to explain big bang theory and galaxies
3. After studied unit-3, the student will be able to demonstrate variety of stars.
4. After studied unit-4, the student will be able to describe the complete details of solar system including comets.
5. After studied unit-5, the student will be able to the units to be used for the measurements celestial distance and coordinates.

**OPEN ELECTIVE  
PAPER-4**

**C. WEATHER FORECASTING**

**Course Objectives**

1. To learn about the elementary idea of atmosphere, atmospheric pressure etc.
2. To study how to measure wind speed, direction, rain fall etc.
3. To teach the different weather systems and hurricanes
4. To explain the climate and environmental issues related to climate
5. To give an idea about weather forecasting

**UNIT-1: Introduction to atmosphere**

Elementary idea of atmosphere: physical structure and composition; compositional layering of the atmosphere; variation of pressure and temperature with height; air temperature; requirements to measure air temperature; temperature sensors: types; atmospheric pressure: its measurement; cyclones and anticyclones: its characteristics.

**UNIT-2: Measuring the weather**

Wind; forces acting to produce wind; wind speed direction: units, its direction; measuring wind speed and direction; humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws.

**UNIT-3: Weather systems**

Global wind systems; air masses and fronts: classifications; jetstreams; local thunderstorms; tropical cyclones: classification; tornadoes; hurricanes.

**UNIT-4: Climate and Climate Change**

Climate: its classification; causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate.

**UNIT-5: Basics of weather forecasting**

Weather forecasting: analysis and its historical background; need of measuring weather; types of weather forecasting; weather forecasting methods; criteria of choosing weather station; basics of choosing site and exposure; satellites observations in weather forecasting; weather maps; uncertainty and predictability; probability forecasts.

**Text Books**

**Unit 1 to Unit 5**

1. Chandrasekar, Basics of Atmospheric Science, PHI Learning Pvt Ltd, New Delhi, 2010
2. Howard J Critchfield, General Climatology, Prentice Hall of India, Pvt Ltd, New Delhi, 1975

## Reference Books

1. I.C. Joshi , Aviation Meteorology, Himalayan Books, 2014
2. Stephen Burt, The weather Observers Hand book, Cambridge University Press, 2012
3. S.R. Ghadekar ,Meteorology,Agromet Publishers, Nagpur, 2001.
4. S.R. Ghadekar ,Text Book of Agrometeorology,AgrometPublishers,Nagpur, 2005
5. Charls Franklin Brooks Why the weather, Chpraman& Hall, London. 1924
6. John G. Harvey,Atmosphere and Ocean, The Artemis Press, 1995.

## E-Materials

1. <https://en.wikipedia.org/wiki/Atmosphere>
2. <https://www.youtube.com/watch?v=6LkmD6B2ncs>
3. <https://www.youtube.com/watch?v=jTWwnUIygc8>
4. <https://weatherstationguide.com/measure-wind-speed/>
5. <https://en.wikipedia.org/wiki/Thunderstorm>
6. <https://en.wikipedia.org/wiki/Cyclone>
7. <https://www.toppr.com/guides/science/winds-storms-and-cyclones/thunderstorms-and-cyclones/>
8. <https://climatekids.nasa.gov/weather-climate/>
9. <https://en.wikipedia.org/wiki/Climate>
10. [https://en.wikipedia.org/wiki/Weather\\_forecasting](https://en.wikipedia.org/wiki/Weather_forecasting)
11. <https://www.skymetweather.com/15-days-rainfall-forecast-for-india/>

## Course Outcomes

1. After studied unit-1, the student will be able to study the atmosphere and its physical structure and also to know the variation of pressure and temperature with height
2. After studied unit-2, the student will be able to describe the measurement of wind speed, direction humidity, rainfall and can state the radiation laws
3. After studied unit-3, the student will be able to explain the global wind systems and able to know thunderstorms and cyclones
4. After studied unit-4, the student will be able to conceptualize the classification of climate, ozone depletion, acid rain and environmental hazards due to climate change
5. After studied unit-5, the student will be able to understand the analysis and historical background of weather forecasting and know the predictability, probability of forecasts

## **CORE PRACTICAL-3**

**Semester: III& IV**

### **ADVANCED GENERAL EXPERIMENTS**

#### **List of Experiments(Any 10 Experiments only)**

1. Determination of the velocity and compressibility of the given liquid using ultrasonic interferometer.
2. Determination of the wavelength of given monochromatic source and the difference in wavelength of the two spectral lines D1 and D2 of Sodium source using Michelson Interferometer.
3. Magnetic susceptibility of a paramagnetic solution using Quincke's tube Method.
4. Determination of magnetic susceptibility of liquid by Guoy method.
5. Determination of the coercivity, retentivity and saturation magnetization of the given material using hysteresis loop tracer equipment.
6. Determination of numerical aperture of an optical fiber by using He-Ne Laser.
7. Determination of diameter of the given thin wire by diffraction method using He-Ne-Laser.
8. Determination of focal length of a given lens using He-Ne laser.
9. Determination of diameter of the given pinhole using He-Ne laser.
10. Determination of Planck's constant.
11. To measure the ionizing radiation from the given source using GM counter experiment
12. Determination of Hall coefficient, mobility, Hall angle and number of charge carriers by using Hall setup
13. Analysis of XRD spectrum - Determination of lattice parameters of a crystal
14. Analysis of FTIR spectrum – Vibrational assignments of a given sample
15. UV-Vis spectrometer - Analysis of UV- Vis spectrum - Determination of absorption coefficient and band gap

## **CORE PRACTICAL-4**

**Semester: III& IV**

### **PROGRAMMING & PROBLEM SOLVING SKILLS**

**List of Experiments (Any 15 out of the given 20)**

#### **I Microprocessor 8085 programs**

(Choose maximum of six programs)

1. Number conversion - 8 bit and 16 bit: BCD to Binary, Binary to BCD
2. Square and square root of BCD and HEX numbers (both 8 and 16 bit).
3. Largest and smallest numbers in a data set
4. Sum of simple series
5. Interfacing (i) Op-amp 8 bit DAC R-2R network (ii) Switching an array of LEDs.
6. ADC and interfacing IC 0809 with MPU
7. Analog to digital conversion using a DAC Comparator and MPU system.
8. Interfacing a DC stepper motor to the MPU system - clockwise and anticlockwise – full Stepping and half stepping
9. Interfacing and programming IC 0800 with MPU – Unipolar and Bipolar.
10. Interfacing a HEX keyboard to the MPU system through I/O ports.

#### **II Microcontroller 8051 Programs**

(Choose maximum of 4 programs)

1. Addition, Subtraction
2. Multiplication and Division.
3. BCD to Binary conversion and binary to BCD
4. Sorting in ascending and descending order.
5. Stepper motor interface.

#### **III Problem Solving Skills**

(Solve minimum five problems and one problem from each topic)

Topics from NET-Physical Sciences-PART “A “CORE Syllabus

1. Mathematical Physics
2. Classical Mechanics
3. Electromagnetic theory
4. Quantum mechanics
5. Thermodynamics and statistical physics

## **CORE PAPER-COMPULSORY**

### **Project with viva voce**

#### **Preamble**

The concept of introducing the project will help the student community to learn and apply the principles of Physics and explore the new research avenues.

In the course of the project the student will refer books, Journals or collect literature / data by the way of visiting research institutes/ industries. He/she may even do experimental /theoretical work in his/her college and submit a dissertation report with a minimum of 40 pages not exceeding 50 pages.

#### **Format for Preparation of Dissertation**

The sequence in which the dissertation should be arranged and bound should be as follows

1. Cover Page and title Page
2. Declaration
3. Certificate
4. Abstract (not exceeding one page)
5. Acknowledgement (not exceeding one page)
6. Contents (12 Font size, Times new Roman with double line spacing)
7. List of Figures/ Exhibits/Charts
8. List of tables
9. Symbols and notations
10. Chapters
11. References

#### **Distribution of marks for Dissertation : (25+75 = 100 Marks)**

##### **Internal : 25 Marks**

##### **External : 75 Marks**

- |   |            |
|---|------------|
| (a) For Organization and presentation of Thesis   | - 40 marks |
| (b) For the novelty /Social relevance   | -10 marks  |
| (c) Presentation of work /Participation in state/<br>(d) national level Seminar/publication | - 5 marks  |
| (e) Viva voce (Preparation, Presentation of<br>work and Response to questions)              | - 20 marks |

## **Massive Open Online Courses (MOOCs)**

**Students can choose any two courses which are available on SWAYAM- NPTEL**

1. A Brief Course On Superconductivity
2. Electromagnetism
3. Electronic Theory Of Solids
4. Experimental Physics - II
5. Experimental Physics III
6. Fiber Optics
7. Group Theory Methods In Physics
8. Introduction To Atmospheric And Space Sciences
9. Optical Sensors
10. Physics Of Biological Systems
11. Physics Through Computational Thinking
12. Quantum Mechanics I

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