ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION
(A Statutory body of the Government of Andhra Pradesh)

REVISED UG SYLLABUS UNDER CBCS
(Implemented from Academic Year 2020-21)

PROGRAMME: FOUR YEAR B.Sc. (Hons)
Domain Subject**: PHYSICS**

4-YEAR UG HONOURS PROGRAM Semester VII & VIII
(Syllabus with Learning Outcomes, References, Co-curricular Activities & Model Q.P. Pattern)

1. 4^{th} year shall have two semesters Sem VII and Sem VIII.
2. Semesters VII and VIII shall have 6 courses each. A total of 12 courses for the 4th year.
3. Of the 6 courses in each of Semesters VII and VIII, 5 courses are Subject related and 1 course shall mandatorily be OPEN Online course in any discipline, encouraging transdisciplinary learning.
4. Three of the five Subject related courses in Sem VII shall be of higher order knowledge (like courses being offered in PG program) and two of the five Subject related courses in Sem VII shall be skill oriented (preferably a continuation of the Skill Enhancement Courses offered in 5^{th} / 6^{th} Sem.).

Prologue

For Semester–VII, for the domain subject Physics, any one of the two Streams (A or B) shall be chosen as courses from 8 to 13, i.e., 8A to 13A or 8B to 13B. The stream shall not be broken, as they are designed with specific objectives as mentioned below:

Stream A consists of six core courses and four skill courses from Physics. This stream is designed for learners who wish to appear for the CSIR exam and aspire to pursue Ph.D. or PDF. A strong **mathematical foundation** is a prerequisite for Stream A.

Stream B, on the other hand, consists of six core courses and four skill courses **from Applied Physics**. This stream is more suitable even for **non-mathematical B.Sc. students** who wish to get into employment soon after the four-year degree program. Stream B is interdisciplinary in nature and based on the latest evolving technologies, which suits modern lifestyles.

Similarly
For Semester–VIII, for the domain subject Physics, any one of the two Streams (A or B) shall be chosen as courses from 14 to 19, i.e., 14A to 19A or 14B to 19 B.

Structure of Syllabus for Semester–VII & VIII

(To choose one stream from the two alternate pairs)

Semester–VII- Stream-A

Univ. Code	Course No.	Name of Course	Th. Hrs / Week	Pr. Hrs/ Week	IE Marks	EE Marks	Total Marks	Credits	Remarks
	8A	Classical and Statistical Mechanics	**6**	**0**	**25**	**75**	**100**	**5**	
	9A	Atomic and Molecular Spectroscopy	**6**	**0**	**25**	**75**	**100**	**5**	
	10A	Mathematical Physics	**6**	**0**	**25**	**75**	**100**	**5**	
	11A	Solid State Physics (Skill Oriented)	**3**	**0**	**25**	**75**	**100**	**3**	
	12A	Analog and Digital Electronics(Skill Oriented)	**3**	**0**	**25**	**75**	**100**	**3**	
	11A-Lab-1	Solid State Physics (Skill Oriented) - Practical	**0**	**3**	**50**	**50**	**100**	**2**	
	12A-Lab-2	Analog and Digital Electronics(Skill Oriented) - Practical	**0**	**3**	**50**	**50**	**100**	**2**	
	13A	* Choose a MOOCs from SWAYAM / NPTEL / Open online Course	**-**		**-**	**-**		**5**	
		TOTAL	**24**	**6**	**225**	**475**	**700**	**30**	

OR

Semester–VII - Stream-B

Univ Code	Course No.	Name of Course	Th. Hrs / Week	Pr. Hrs/ Week	IE Marks	EE Marks	Total Marks	Credits	Remarks
	8B	Materials Science for Industrial Applications	**6**	**0**	**25**	**75**	**100**	**5**	
	9B	Analytical Techniques	**6**	**0**	**25**	**75**	**100**	**5**	
	10B	Advances in Physics	**6**	**0**	**25**	**75**	**100**	**5**	
	11B	Condensed Matter Physics (Skill Oriented)	**3**	**0**	**25**	**75**	**100**	**3**	
	12B	VLSI design (Skill Oriented)	**3**	**0**	**25**	**75**	**100**	**3**	
	11B-Lab-1	Condensed Matter Physics (Skill Oriented) – Practical	**0**	**3**	**50**	**50**	**100**	**2**	
	12B-Lab-2	VLSI design (Skill Oriented) – Practical	**0**	**3**	**50**	**50**	**100**	**2**	
	13B	***** Choose a MOOCs from SWAYAM / NPTEL / Open online Course	**-**		**-**	**-**		**5**	
		TOTAL	**24**	**6**	**225**	**475**	**700**	**30**	

***** It is a mandatory course. Students shall be allowed to register and appear for MOOCs of his / her own choice from SWAYAM / NPTEL / Open online Course, which is not covered in the syllabus,. Faculty could suggest the available / suitable online courses to the students at the beginning of the VII semester. The students have to complete the MOOCs successfully and submit the pass certificate of the same to the University through the Principal of the College concerned for the approval and endorsement of the same on the grade cards and PCs and ODs as per the regulations of the University.

Semester–VIII - Stream-A

Univ Code	Course No.	Name of Course	Th. Hrs / Week	Pr. Hrs/ Week	IE Marks	EE Marks	Total Marks	Credits	Remarks
	14A	Quantum Mechanics	**6**	**0**	**25**	**75**	**100**	**5**	
	15A	Applied spectroscopy	**6**	**0**	**25**	**75**	**100**	**5**	
	16A	Nuclear and Particle Physics	**6**	**0**	**25**	**75**	**100**	**5**	
	17A	Microprocessor & Microcontrollers (Skill Oriented)	**3**	**0**	**25**	**75**	**100**	**3**	
	18A	Modern Optics (Skill Oriented)	**3**	**0**	**25**	**75**	**100**	**3**	
	17A-Lab-1	Microprocessor & Microcontrollers (Skill Oriented)	**0**	**3**	**50**	**50**	**100**	**2**	
	18A-Lab-2	Modern Optics (Skill Oriented)	**0**	**3**	**50**	**50**	**100**	**2**	
	19A	* Choose a MOOCs from SWAYAM / NPTEL / Open online Course	**-**		**-**	**-**		**5**	
		TOTAL	**24**	**6**	**225**	**475**	**700**	**30**	

OR

Semester–VIII - Stream-B

Univ Code	Course No.	Name of Course	Th. Hrs / Week	Pr. Hrs/ Week	IE Marks	EE Marks	Total Marks	Credits	Remarks
	14B	Fibre Optics	**6**	**0**	**25**	**75**	**100**	**5**	
	15B	Nanomaterials and Devices	**6**	**0**	**25**	**75**	**100**	**5**	
	16B	Energy Storing Devices	**6**	**0**	**25**	**75**	**100**	**5**	
	17B	Embedded Systems(Skill Oriented)	**3**	**0**	**25**	**75**	**100**	**3**	
	18B	Photonics (Skill Oriented)	**3**	**0**	**25**	**75**	**100**	**3**	
	17B-Lab-1	Embedded Systems(Skill Oriented)	**0**	**3**	**50**	**50**	**100**	**2**	
	18B-Lab-2	Photonics (Skill Oriented)	**0**	**3**	**50**	**50**	**100**	**2**	
	19B	* Choose a MOOCs from SWAYAM / NPTEL / Open online Course	**-**		**-**	**-**		**5**	
		TOTAL	**24**	**6**	**225**	**475**	**700**	**30**	

***** It is a mandatory course. Students shall be allowed to register and appear for MOOCs of his / her own choice from SWAYAM / NPTEL / Open online Course, which is not covered in the syllabus,. Faculty could suggest the available / suitable online courses to the students at the beginning of the VII semester. The students have to complete the MOOCs successfully and submit the pass certificate of the same to the University through the Principal of the College concerned for the approval and endorsement of the same on the grade cards and PCs and ODs as per the regulations of the University.

Structure of Syllabus for Semester–VII
Higher Order Knowledge Cources

Univ. Code	Cource No. and Name of Course	Th. Hrs / Week	Pr. Hrs/ Week	IE Marks	EE Marks	Total Marks	Credits	Remarks
	8A Classical and Statistical Mechanics (OR) **8B** Materials Science for Industrial Applications	**6**	**0**	**25**	**75**	**100**	**5**	
	9A Atomic and Molecular Spectroscopy **(OR)** **9B** Analytical Techniques	**6**	**0**	**25**	**75**	**100**	**5**	
	10 A Mathematical Physics **(OR)** **10B** Advances in Physics	**6**	**0**	**25**	**75**	**100**	**5**	
	Total	**18**	**0**	**75**	**225**	**300**	**15**	

Semester VII
Skill oriented Cources

Univ. Code	Cource No. and Name of Course	Th. Hrs / Week	Pr. Hrs/ Week	IE Marks	EE Marks	Total Marks	Credits	Remarks
	11A Solid State Physics **(OR)** **11B Condensed** Matter Physics	**3**	**0**	**25**	**75**	**100**	**3**	
	12A Analog and Digital Electronics **(OR)** **12B** VLSI design	**3**	**0**	**25**	**75**	**100**	**3**	
	TOTAL	**6**	**0**	**50**	**150**	**200**	**6**	

Semester VII
Skill Oriented Practical

Univ. Code	Cource No. and Name of Course	Th. Hrs / Week	Pr. Hrs/ Week	IE Marks	EE Marks	Total Marks	Credits	Remarks
	11A Lab 1 Solid State Physics - Practical **(OR)** **11B Lab 1**Condensed Matter Physics	**0**	**3**	**50**	**50**	**100**	**2**	
	12A Lab 2 Analog and Digital Electronics - Practical **(OR)** **12B Lab 2** VLSI design Practical	**0**	**3**	**50**	**50**	**100**	**2**	
	* Choose a MOOCs from SWAYAM / NPTEL / Open online Course	**0**	**0**	**0**	**0**	**0**	**5**	
	TOTAL	**0**	**6**	**100**	**100**	**200**	**9**	

Semester–VIII
Higher Order Knowledge courses

Univ Code	Cource No and Name of Course	Th. Hrs / Week	Pr. Hrs/ Week	IE Marks	EE Marks	Total Marks	Credits	Remar ks
	14A Quantum Mechanics **(OR)** **14B** Fibre Optics	**6**	**0**	**25**	**75**	**100**	**5**	
	15A Applied spectroscopy **(OR)** **15B** Nanomaterials and Devices	**6**	**0**	**25**	**75**	**100**	**5**	
	16A Nuclear and Particle Physics **(OR)** **16B** Energy Storing Devices	**6**	**0**	**25**	**75**	**100**	**5**	
	Total	**18**	**0**	**75**	**225**	**300**	**15**	

SEMESTER VIII
Skill Oriented Courses

Univ Code	Cource No and Name of Course	Th. Hrs / Week	Pr. Hrs/ Week	IE Marks	EE Marks	Total Marks	Credits	Remar ks
	17A Microprocessor & Microcontrollers **(OR)** **17 B** Embedded Systems	**3**	**0**	**25**	**75**	**100**	**3**	
	18A Modern Optics **(OR)** **18B** Photonics	**3**	**0**	**25**	**75**	**100**	**3**	
	Total	**6**	**0**	**150**	**150**	**200**	**6**	

Semester VIII
Skill Oriented Practical

Univ Code	Cource No and Name of Course	Th. Hrs / Week	Pr. Hrs/ Week	IE Marks	EE Marks	Total Marks	Credits	Remarks
	17A Lab 1 Microprocessor & Microcontrollers **(OR)** **17 B Lab 1** Embedded Systems	**0**	**3**	**50**	**50**	**100**	**2**	
	18A Lab 2 Modern Optics **(OR)** **18B Lab 2** Photonics	**0**	**3**	**50**	**50**	**100**	**2**	
	19A/19B * Choose a MOOCs from SWAYAM / NPTEL / Open online Course						**6**	
	Total	**0**	**6**	**100**	**100**	**200**	**9**	

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Semester wise Revised Syllabus under CBCS 2020-21
Four Year – B.Sc. (Hons), STREAM A (VII-SEMESTER)
Domain Subject: PHYSICS

8A: CLASSICAL AND STATISTICAL MECHANICS

Hours/Week: 6
Credits: 5

Course Objectives: To equip students with a strong foundation of the Lagrangian and Hamiltonian formalisms for one and many particle systems, as well as the concepts of phase space, ensembles, and partition functions and their applications in Statistical Mechanics.

Course Outcomes

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

CO1: Describe the principles and the mathematical techniques used in Newtonian Mechanics of one
and many particle systems and their applications.

CO2: Solve problems using Canonical Transformations and Hamilton - Jacobi theory

CO3: Explain motion in central force fields, Kepler's laws of planetary motion and gyroscopes.

CO4: Calculate the translational, rotational, and vibrational partition functions for molecules in different energy states.

CO5: Summarize the concepts of Maxwell – Boltzmann, Bose – Einstein and Fermi – Dirac Statistics and Black body radiation using Planck's radiation law.

UNIT – I: Lagrangian Mechanics and Hamiltonian Mechanics 14 Hrs

Newtonian mechanics of one and many particle systems: Conservation laws, Constraints and their classification, Degrees of freedom: Generalized coordinates: Principle of virtual work, D'Alembert's principle, Lagrange's equations of motion.

Applications: Inclined plane, Linear harmonic oscillator and simple pendulum, Hamiltonian principle, Lagrange's equation from Hamilton's principle, Hamilton's equation of motion, Applications, Simple pendulum, Compound pendulum.

UNIT – II: Canonical Transformations and Hamilton - Jacobi Theory 14 Hrs

Canonical Transformations, Generating function and their properties, Condition for transformation to be canonical, Illustration of canonical transformation, Poisson – Brackets, Canonical equations in terms of Poisson, Bracket notation-Lagrange-Brackets and their properties.

Hamiltonian - Jacobi equation, one dimensional harmonic oscillator, Small oscillations and normal modes, Action Angle variables, Kepler problem in action angle variables.

UNIT –III: Motion in a Central Force Field 12 Hrs

Reduction to the equivalent one body problem; Motion in a central force field: Conditions for closed orbits: Inverse square law of forces: Kepler's laws of planetary motion; Rutherford scattering. Rotations – Space and body fixed axes: Angular momentum and Torque; Eulerian angles – Euler's equations of a rigid body: Motion of symmetrical top; Expression for slow and fast precessions; Larmour precision; Gyroscope.

UNIT- IV: Ensembles and Partition Functions **12 Hrs**

Phase space – Concept of ensembles – Types of ensembles - Ensemble average - Liouville's Theorem – Micro canonical ensemble: ideal gas – Gibb's paradox Canonical partition function – Molecular partition function – Transnational partition function – Rotational partition function – Vibrational partition function

UNIT – V: Maxwell – Boltzmann, Bose – Einstein and Fermi – Dirac Statistics **12 Hrs**

Maxwell - Boltzmann distribution - Equipartition energy. Bose – Einstein distribution, Bose – Einstein condensation, Black body radiation and the Planck's radiation law - Fermi - Dirac distribution – One dimensional random walk – Random walk and Brownian motion.

List of Activities:

1. Assignments
2. Student Seminars

Recommended Books

1. Classical Mechanics, N.C. Rana and P.S. Joag - Tata Mc-Graw Hill, 1991.
2. Classical Mechanics, J.C. Upadyaya - Himalaya Publishing House, 2005.
3. Classical Mechanics, Gupta, Kumar and Sharma –Pragathi Prakashan, 2012.
4. Introduction to Classical Mechanics, R.G. Takwale and P.S. Puranic -Tata McGraw-Hill, 1989.
5. Statistical Mechanics, B.K. Agarwal, Melvin Eisner, 2nd Edition, New Age International (P)Ltd.
6. Statistical Mechanics and properties of Matter by ESR Gopal, Student Edition (Ellis Horwood)

Reference Books

1. Classical Mechanics, H. Goldstein - Addison Wesley, 1980.
2. Classical Dynamics of Particles, J.B.Marion Academic Press -Saunders College Publications, 4th edition, 1995.
3. Statistical and Thermal Physics , F. Reif, 4th Edition, McGraw Hill
4. Elementary Statistical Mechanics, C. Kittel, Dover Publications
5. Foundations of Classical mechanics by P. C. Deshmukh, Cambridge University Press

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Domain Subject: PHYSICS

9A: ATOMIC AND MOLECULAR SPECTROSCOPY

Hours/Week: 6
Credits: 5

Course Objectives: To provide students with a strong foundation in the principles and theories of atomic and molecular physics, and their industrial applications for material characterization.

Course Outcomes

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

CO1: Discuss atomic structure using vector atom model, coupling schemes, and Absorption, emission and excitation spectra.

CO2: Interpret experimental results related to Zeeman effect, Paschen-Back effect, and Stark effect and evaluate electron transitions and energy levels in atoms.

CO3: Describe origin of X-ray radiations, measurements, reflection, refraction and diffraction of X-rays and their applications.

CO4: Analyze the rotational, vibrational, and electronic spectra of molecules using spectroscopic techniques, energy levels and spectrum – PQR branches, Frank Condon principle and applications of vibrational spectroscopy.

CO5: Explain the theory of Raman Scattering, rotational and vibrational Raman spectra and industrial applications of Raman spectroscopy.

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UNIT I: Atomic Spectra **14 Hrs**

Introduction: Vector atom model –Spectra of Alkali elements-fine structure- Spectral terms and term symbols, Ground states based on electron configuration - Coupling schemes - LS coupling - JJ coupling- Hund's rule of multiplicity - Equivalent and non-equivalent electronic systems. Spectral terms for equivalent and non-equivalent electrons - Width of spectral lines –Absorption, emission and excitation spectra-Spectrophotometer – Applications of atomic spectra – Photo Electron Spectroscopy-Atomic absorption spectroscopy.

UNIT II: Zeeman and Stark Effects **13 Hrs**

Introduction: Zeeman effect- Normal and anomalous Zeeman effects - Experimental details - Magnetic moment of atom and Lande's 'g'-factor - Zeeman effect in sodium atom - Lande g-formula for LS and JJ couplings - Paschen-Back effect - Splitting of sodium lines and selection rules - Stark effect - Experimental details - Weak and strong field effects – linear and quadratic Stark effects -Width of spectral lines.

UNIT III: X-ray Spectra **12 Hrs**

Production of X-rays-Origin of X-ray radiations-X-rays Light and electromagnetic spectrum-Measurement of X-radiations-polarization of X-radiations-Diffraction of X-radiations-Braggs law-Laue spots-Bragg's spectrometer-Reflection and Refraction of X-ray-X-ray scattering-Applications of X-rays

UNIT IV: Molecular Spectroscopy – Rotational – Vibrational Spectra 14 Hrs

Introduction – Rotational, vibrational and electronic spectra of diatomic molecules – Rotational spectra of a diatomic molecule as rigid rotator and non-rigid rotor – Intensity of rotational lines - Rotational analysis of electronic spectra- Evaluation of rotational constants - Effect of isotopic substitution on rotational levels – Applications of rotational spectroscopy. Vibrational spectra of diatomic molecule – Diatomic molecule as a simple harmonic oscillator and anharmonic oscillator – Energy levels and spectrum – PQR branches – Progressions and sequences – Vibrational analysis of electronic spectra - DE slander's table – Evaluation of vibrational constants – Morse potential energy curve – Frank-Condon principle – Intensity distribution in absorption and emission spectra –IR and FTIR spectrometers - Applications of vibrational spectroscopy.

UNIT-V: Raman Spectroscopy 12 Hrs

Introduction-Theory of Raman Scattering-Rotational and Vibrational Raman spectra-Mutual Exclusion Principle-Raman spectrometer-Fiber Coupled Raman Spectrometer-FT Raman Spectrometer- Structure determination using IR and Raman Spectroscopy-Industrial applications of Raman spectroscopy

List of Activities:

1. Assignments
2. Student Seminars

Recommended Books

1. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw - Hill Book company, Inc., (1962).
2. Molecular Structure and Spectroscopy, G. Aruldhas, Prentice- Hall of India, Pvt., New Delhi, (2005).
3. Elements of spectroscopy atomic, molecular and Laser physics, Gupta, Kumar, Sharma, Pragathi Prakashan, Meerut.
4. Atomic and Molecular Spectroscopy by Rita Kakkar, Cambridge University Press

Reference Books

1. Introduction to Atomic Spectra, H.E. White, McGraw-Hill Kogakusha. Ltd., New Delhi (1934).
2. Fundamentals of Molecular Spectroscopy, C.N. Banwell, E.M. Mc Cash, Tata McGraw-Hill Pub.. (1994)
3. Spectroscopy, Vol. I & III, B.P. Straughan and S. Walker, John Wiley & Sons Inc., New York. (1976).

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10 A: MATHEMATICAL PHYSICS

Hours/Week: 6
Credits: 5

Course Objectives: To provide students with a strong foundation in the Mathematical principles, and and enable students to apply the knowledge of special functions, integral transforms, tensors, numerical techniques and complex variables in Physics.

Course Outcomes
Upon the successful completion of the course, students will be able to:
CO1: Develop proficiency in solving Legendre, Bessel, and Hermite differential equations using various techniques, including power series, generating functions, and recurrence relations.
CO2: Summarize the properties of Fourier transforms, Laplace transform, their significance in analyzing Square wave, sawtooth wave and triangular waves, linear differential equations and their applications.
CO3: Apply tensor theory to model and analyze physical phenomena, including strain, thermal expansion, and piezoelectricity.
CO4: Analyze the physical significance of various Numerical methods and techniques in solving differential equations.
CO5: Discuss the basic concepts of complex functions, complex differentiation, and complex integration in evaluating definite integrals

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UNIT-I: Special Functions **12 Hrs**
Beta and Gamma Functions – Definitions and properties – Evaluation of integrals, Legendre, Bessel and Hermite differential equations– Solutions– Generating functions– Orthogonal properties of Legendre, Bessel and Hermite Functions (Proof not necessary) – Recurrence relations– (Proof for Legendre polynomials only).

UNIT-II: Integral Transforms **15 Hrs**
Fourier Transforms: Properties of Fourier transforms – Fourier sine and cosine transforms-Power in Fourier series – Modulation theorem, Fourier transform of impulse function, Constants, Unit step function and Periodic functions.

Laplace Transforms: Definition and notation – Properties of Laplace transforms – Laplace transforms of Dirac delta function and periodic functions (Square wave, sawtooth wave and triangular wave) –Inverse Laplace transforms– properties– Solution of linear differential equations with constant coefficients - Applications to LCR circuits and resonance of simple pendulum.

UNIT III: Tensors **12 Hrs**
Definition – Contravariant, Covariant and Mixed tensors – Dummy suffix notation- Addition, subtraction, contraction, inner product, outer product, symmetric and anti-symmetric tensors - Application of Tensor theory to strain, thermal expansion and piezoelectricity.

UNIT-IV: Numerical Techniques **14 Hrs**

Solution of an equation – Bisection method, Regular False method, Newton – Rhapson method Solutions of simultaneous– Gauss elimination method and Gauss-Seidel method – Interpolations-Newton's interpolation and Lagrange's interpolation, Curve fitting – Method of Least squares Numerical differentiation and integration – Trapezoidal rule and Simpson's 1/3 rule – Solutions of differential equations– Euler's method and Runga-kutta Methods.

UNIT–V: Complex Variables **13 Hrs**

Functions–Complexdifferentiation-Analyticfunction-Cauchy–Riemannequations – Derivatives of elementary functions – Singular points and classification. Complex integration -Cauchy's theorem – Integrals of special functions – Cauchy's integral formula – Taylor's and Lorentz theorem (statements only) – Residues, calculations of residues - Residue theorem – evaluation of definite integrals.

List of Activities:

1. Assignments
2. Student Seminars
3. Problem solving Sessions

Recommended Books

1. Mathematical physics,B.D.Gupta,4th edition,Vikaspublishinghouse,2010
2. Mathematical physics, B.S. Rajput,Pragati PrakashanMeerut,2017
3. Theory and Properties of Complex Variables, Schaum'soutline series, Murray R.Spiegel, Seymour Lipschutz, John J. Schiller, Dennis Spellman, McGraw-Hill, 1976
4. Applied Fourier analysis, Hweipiao Hsu, UnitechDivision,1984
5. An Introduction to Mathematical Physics, Suresh Chandra, Mohit Kumar Sarma Alpha Science International, 2013.

Reference Books

1. Special Functions for Scientists and Engineers, W.W. Bell, Dover Publications,2013
2. Laplace Transforms, Murray Spiegle, Schaum' soutline series, Mc Graw Hill, International Book Company, NY, 2005
3. Applied Mathematics for Engineers, Louis A. Pipes, Lawrence R. Harvill, Courier Corporation,2014
4. Complex Variables and Applications, Brown and Churchill, McGraw–Hill,2013
5. Mathematical Methods for Physics and Engineering ... K. F. Riley, University of Cambridge,

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11A: SOLID STATE PHYSICS (Skill Oriented)

Hours/Week: 3
Credits: 3

Course Objectives: To provide students with a strong foundation of theory of crystallography, defects in crystals, transport phenomena, semiconductors and superconductivity and prepare them for careers in academic or industrial research.

Course Outcomes
Upon the successful completion of the course, students will be able to:
CO1: Explain the structure of crystals using Bravis lattices, types of binding and binding forces, elastic properties of crystals, lattice vibrations and phonons.
CO2: Discuss various types of defects in crystal structures, and their effects on material properties and behavior**.**
CO3: Outline the significance of transport phenomena and distinguish metals, insulators and semiconductors based on band theory.
CO4: Describe the nature of intrinsic and extrinsic semiconductors, fermi levels and its variation with temperature and direct and indirect band gap semiconductors.
CO5: Summarize the concepts of superconductivity and analyze the potential applications of superconductors.

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UNIT–I: Crystallography, Lattice Energies and Lattice Vibrations 12 Hrs
Bravais lattices – Reciprocal lattice –X-ray diffraction – structural factor. Origin of chemical binding in ionic and van der Waals crystals – Elastic properties – Stress and strain –Elastic moduli -– Lattice vibrations: Mono and diatomic one dimensional infinitely long lattices – Phonons – properties.

UNIT-II: Defects in Crystals 12 Hrs
Impurities-vacancies-Schottky and Frenkel vacancies-Extrinsic vacancies- Kirkendall effect-Color centers and colaration of crystals – F-Centers, V-Centers, Line Defects (the dislocations)-Geometry of dislocations, Screw dislocations

UNIT– III: Transport Phenomena and Band Theory 14 Hrs
Concept of electrical and thermal resistivity – Expression for thermal and electrical conductivities for metals – Lorenz number - Matheissens rule- Distribution function –Formulation of Boltzmann transport equation
Bloch function –Kroning - Penny model – Formation of energy bands in solids –Brillouin zones

UNIT–IV: Semiconductor Physics **12 Hrs**

Intrinsic and extrinsic semiconductors–Expression for position of Fermi levels and carrier concentrations – Variation of Fermi level with temperature – np product –Direct and indirect band gap semiconductors–Hall effect Heyness- Schockley experiment – Determination of lifetime, diffusion length of minority charge carriers.

UNIT–V: Superconductivity **13 Hrs**

Concept of zero resistance – Magnetic behavior– Meissner effect – Isotope effect – Specific heat behavior – London's equations – BCS theory –Josephson junctions – SQUIDS and its applications - Applications of superconductors –High TC superconductors

List of Activities:

1. Assignments
2. Student Seminars

Recommended Books

1. Elementary Solid State Physics, M. Ali Omar, 1993, Addison - Wesley.
2. Solid State Physics, M. A.Wahab, Edition: 3rd, 2020, Narosa Publishing House.
3. High TC Superconductivity, C.N.R. Rao and S.V. Subramanyam, world scientific publishing company, 1989
4. Solid State Physics, S.O. Pillai. Edition: 6th, 2009, New Academic Science Ltd
5. Solid State Physics, S.L. Kakani and C. Hemarajan, Edition: 4th, 2005, Sultan Chand and Sons
6. Electrons in Solids, Richard H. Bube, Edition 3rd, 1992 Elsevier,
7. Solid State Physics by R.K. Puri V.K. Babbar Edition: 1st 2017. S. Chand.

Reference Books

1. Solid State Physics, C. Kittel, Edition: 8th 2012, John Wiley & Sons.
2. Solid State Physics, A.J. Dekkar, Edition: 1st, 2000. Macmillan India Ltd.
3. Solid State Electronic Devices, B.G. Streetman. Edition 7th, 2018, Pearson Education India

SEMESTER – VII – Practical Lab Course-1

11-A- LAB-1: Solid State Physics- Practical

Hours/Week: 3
Credits: 2

Course Objectives

To equip, students with experimental skills, by applying the learnt concepts from Solid State Physics.

Course Outcomes

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

CO1: Determine Planck's constant using a photo Cell.
CO2: Estimate Thermo emf of bulk samples.
CO3: Study the characteristics of a Photo Transistor and determine the required parameters.
CO4: Measure the efficiency of a GM counter using the given radiation source.
CO5: Evaluate the lattice constant, grain size of the given material using X-ray Diffraction-technique.
CO6: Determine the coefficient of Young's modulus of the given material.
CO7: Study the variation of magnetic field due to a current carrying conductor using Biot Savart Law.
CO8: Study the I -V characteristics of Solar cell and draw a graph.
CO9: Study the Zeeman Effect using a monochromatic source of light.

Any six of the following experiments:

List of Experiments:

1. Plank's constant determination
2. Thermo emf of bulk samples
3. Photo Transistor characteristics
4. GM counter
5. X-ray Diffraction-Determination of lattice constant, grain size
6. Young's modulus
7. Study of Biot - Severt Law
8. I V characteristics of Solar cell
9. Study of Zeeman effect

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12A: ANALOG AND DIGITAL ELECTRONICS (Skill Oriented)

Hours/Week: 3
Credits: 3

Course Objectives: To develop students' skills in designing, analyzing, and testing both analog and digital circuits and modulation techniques in Communication Electronics.

Course Outcomes
Upon the successful completion of the course, students will be able to:
CO1: Analyze the structure and working of FET, JFET, MOSFET, CMOS circuits, And characteristics and applications of UJT as a relaxation oscillator.
CO2: Explain the block diagram of a typical Op-Amp and its role in various applications and determine various parameters.
CO3: Analyze and design basic circuits using various types of diodes, solar cells, LEDs and semiconductor lasers, and know the principles of operation and applications.
CO4: Develop and analyze the functioning of basic combinational and sequential logic circuits, and know their functioning and applications.
CO5: Describe basic digital communication systems using modulation, and sampling techniques, and know the principles of functioning and applications.

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UNIT–I: Introduction to Electronic Devices: 7 Hrs
Field Effect Transistor (FET): Structure and working - JFET Structure and working, Structure of MOSFET and Characteristics, , Concept of CMOS Structure and working -Characteristics of UJT. Application of UJT as a Relaxation oscillator.

UNIT–II: Operational Amplifiers: 8 Hrs
Block diagram of a typical Op-Amp, differential Amplifier, Comparator open loop configuration, inverting and non-inverting amplifiers. Op-amp with negative feedback, voltage shunt feedback, effect of feedback on closed loop gain, input resistance, output resistance, CMRR, frequency response, slew rate.

UNIT- III: Junction Diodes 7 Hrs
Tunnel diode- I-V characteristics, Schottky barrier diode - operation and applications. Varactor diode, Gunn diode, IMPATT diode, TRAPATT diode, BARITT diode - Solar cell – Structure - Principle of operation – Light Emitting Diodes (LEDs), Semiconductor lasers – principle of operation and applications.

UNIT–IV: Digital Electronics 8 Hrs
Combinational Logic: Multiplexers, Decoder, Demultiplexer, Data selector, Multiplexer, Encoder. Sequential Logic: Flip–Flops, A1-bit memory, The RS Flip-Flop, JK Flip – Flop, JK Master Slave Flip–Flops, T Flip-Flop, D Flip-Flop, Shift Registers,- Asynchronous and Synchronous Counters.

UNIT–V: Communication Electronics **8 Hrs**

Introduction to Modulation (AM & FM), Sampling Theorem, Low pass and Band pass signals, PAM, Channel BW for a PAM signal. Natural sampling, Flattop sampling. Signal recovery through holding. Differential PCM, Delta Modulation, Adaptive Delta modulation CVSD. Signal to noise ratio in PCM and Delta Modulations.

List of Activities:

1. Assignments
2. Student Seminars

Recommended Books

1. OP-Amps & Linear Integrated Circuits, by Ramakanth A. Gayakwad, PHI, 2nd Edition, 1991.
2. Digital Systems by Ronald J. Tocci, 6thEdition, PHI, 1999.
3. Principles of Communications by Taub and Schilling, Mc-Graw Hill Publication.
4. Electronic Principles by Malvino, 6thEd.TMH, 2017
5. Linear Integrated circuits by Roy Choudhry, Pearson,2018
6. Op-Amps – D.K. Mahesh, PHI
7. Basic Electronics by Chinmoy Saha , Cambridge University press

Reference Books

8. Micro Electronics by Milliman and Halkias. TMH Publications
9. Digital Principles and Applications by A.P. Malvino and Donald P.Leach, Tata McGraw-Hill, New Delhi, 1993
10. Electronic Devices and Circuit Theory by Robert Boylested and Louis Nashdsky–Jose Kanedy & Division. PHI, New Delhi, 1991

SEMESTER – VII – Practical Lab Course-2

12-A- LAB-2: Analog and Digital Electronics - Practical

Hours/Week: 3
Credits: 3

Course Objectives

To equip, students with experimental skills, by applying the learnt concepts from Analog and Digital Electronics.

Course Outcomes
Upon the successful completion of this practical course, students will be able to:
CO1: Study the FET Characteristics and determine the respective parameters.
CO2: Study the UJT Characteristics and determine and determent the respective parameters.
CO3: Design Astable Multivibrator using 555-Timer and determine the frequency of oscillation and duty cycle.
CO4: Determine the resonant frequency of oscillation of a Wien's Bridge Oscillator using Op-Amp.
CO5: Study the characteristics of operational amplifier and determine the following parameters (a) Input offset voltage, (b) Input bias current, (c) CMRR (d) Slew rate.
CO6: Study the characteristics of Op-Amp as an integrator, Differentiator & Summation performer
CO8: Design and verify the truth tables of half adder and full adder circuits.
CO9: Design and verify the truth tables of various flip flops circuits (RS, D, JK, T).

Any six of the following experiments:

List of Experiments:

1. FET Characteristics
2. UJT Characteristics
3. 555-Timer – Astable Multivibrator
4. Wien Bridge Oscillator-using Op-Amp
5. Op-amp parameters
   (a) Input offset voltage
   (b) Input bias current
   (c) CMRR
   (d) Slew rate
6. OP-AMP-offset null adjustment-inverting Amplifiers
7. Op-Amp-integration, Differentiation & Summation
8. Design and study of full adder and half adder circuits
9. Design and study of various flip flops circuits (RS, D, JK, T)

13A: Choose a MOOCs SWAYAM/NPTEL Open online Course

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8B: MATERIALS SCIENCE FOR INDUSTRIAL APPLICATIONS

Hours/Week: 6
Credits: 5

Course Objectives:

- To familiarize students with the types of materials commonly used in industrial applications such as organic, liquid crystals, dielectrics, ferroelectrics and thin films, and discuss their structure, properties, behaviour, performance and their applications.

- To prepare students for careers in materials-related industries, such as aerospace, automotive, energy, and biomedical engineering, etc.

Course Outcomes

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

CO1: Describe the structure and properties and behavior of polymers and ceramic materials, and their industrial applications.
CO2: Classify & analyze liquid crystals, properties, and their applications.
CO3: Explain the polarisation theories in dielectrics and analyse its applications in electronic and electrical devices.
CO4: Discuss the types of magnetic materials and theories of ferroelectricity, properties, classification and their industrial applications.
CO5: Outline the theories of thin film nucleation and growth and methods of preparing thin Films, its measurements, properties and various applications.

SYLLABUS

UNIT– I: Basic Concepts in Polymers **8 Hrs**

Definition of monomer & polymer; Classification of polymers; Mechanism of polymerization - Addition (Free radical) and Condensation polymerization; Polymerization techniques - Bulk, Solution, Suspension and Emulsion; Definition of Copolymer (Random, Alternate, Block and Graft) and blends

UNIT–II: Liquid Crystals **7 Hrs**

Introduction to different types of liquid crystals, microscopic and optical properties of different types of nematic, smectic and cholesteric liquid crystal; blue phases. Electrical and dielectric properties of liquid crystal; Chiral liquid crystals. Ferroelectric liquid crystals. Electro-optic and magneto-optic effect of liquid crystals. Display and memory devices. Applications of liquid crystals

UNIT-III: Dielectrics **7 Hrs**

Introduction – Dipole moment – various types of polarization – electronic, ionic and orientational polarization – Langevin's theory – Lorentz field– Clausius- Mosotti equation–Measurement of dielectric constant – Applications of dielectrics.

UNIT–IV: Ferroelectrics **8 Hrs**

Classification of magnetic materials- domain structure. Soft and hard magnetic materials, Ferrites, ceramic magnets. Piezo-, Pyro- and ferroelectric crystals– General properties of ferroelectric materials. Theories of ferroelectricity. Thermodynamic of Ferroelectric transitions. Spontaneous polarization – Classification and properties of ferroelectrics - Ferroelectric domains – Oxygen ion displacement theory –Applications of ferroelectrics.

UNIT–V: Thin films **8 Hrs**

Theories of thin film nucleation and growth. Thin film preparation – Rf sputtering. Chemical vapor deposition. Thickens measurements. Electrical and optical properties of thin films - Applications. Photolithography: Photoresists, Thin film resistors – Thin film capacitors – Thin film diodes and transistors – Thin film solar cells, Thin film micro batteries – Thin film sensors: Gas sensors, Bolometers

List of Activities:

1. Assignments
2. Student Seminars

Recommended Books

1. Fundamentals of Solid State Physics, Saxena, Gupta, Saxena, Pragathi Publications, Meerut.
2. Solid State Physics, R.L. Singhal, Kedar Nath Ram Nath&Co.Pub.
3. Science of Engineering Materials, C.M. Srivastsava and C. Srinivasan, New Age Inter. Pub.
4. Crystal Growth, B.R. Pamplin, Pergmon Press.
5. Introduction to Liquid Crystals, Chemistry and Physics by PJ Collings and Michael Hird,

Reference Books

6. Introduction to Solid State Physics, Charles Kittel VII edition, John Wiley & Sons.
7. Solid State Physics, A.J. Dekker, Mc Millan Publications.
8. Solid State Physics, M.A. Wahab, Narosa Publishing House.

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9B: ANALYTICAL TECHNIQUES

Hours/Week: 6
Credits: 5

Course Objectives: To enable students to summarize the principles, concepts, interpretation of the data and applications of various analytical techniques.

Course Outcomes
Upon the successful completion of the course, students will be able to:
CO1: Analyze the electromagnetic spectrum and types of molecular energies using the basic principles and concepts of spectroscopy.
CO2: Evaluate the molecular structures using the respective tools and techniques of Ultraviolet–visible spectroscopy, IR spectroscopy and Fourier transform infrared (FTIR) spectroscopy**.**
CO3: Outline the principles, operation and applications of spectrophotometers and colorimeters for chemical analysis, TEM and SEM microscopes for structural analysis.
CO4: Describe the principles, salient features, experimental techniques, working and applications of ESR, NMR, Mossbauer spectrometers in Modern Science.
CO5: Explain materials characterization using spectral data obtained from by EDS, XPS, XRF, AES, SIMS, SEM, TEM, AFM and XRD applying advanced spectroscopic and microscopic techniques .

SYLLABUS

UNIT I: Basic Elements of Spectroscopy **12 Hrs**
Introduction – Electromagnetic spectrum-Types of molecular energies-Different spectroscopic Methods-An overview-Spectral line width-Absorption and Emission of radiation-Einstein's coefficients-Lasers

UNIT– II: Spectrophotometry **14 Hrs**
Introduction – Beer's law – Absorptivity – UV and visible absorption – Instrumentation – Essential parts of spectrophotometer – Gratings and prisms – Radiant energy sources – Filters – Photosensitive detectors – Barrier layer cells – Photo emissive cells – Photomultiplier tubes – Relationship between absorption in the visible and UV region and molecular structure – IR Spectrophotometry – Fourier Transform Infrared (FTIR) Spectrometer – Molecular structure – Qualitative and Quantitative analysis – Importance of photography in the spectrochemical analysis.

UNIT–III : Colorimeters, spectrophotometers and microscopes **14 Hrs**
Colorimeter – Principle - Applications of colorimeters in Solid State Physics and biomedical purposes Spectrophotometer – Principle and working with block diagram – Salient features of individual blocks – Specifications and operation of spectrophotometers – Applications of spectrophotometers to chemical analysis Electron microscope – Transmission electron microscope - Principle and working with block diagram –Salient features of individual blocks – Scanning

electron microscope - Principle and working with block diagram – Description of individual blocks– Applications of electron microscopes.

UNIT–IV : Resonance spectrometers and Mass Spectrometer 14 Hrs

Electron spin resonance – theory – ESR spectrometer – Principle and working with block diagram – Experimental techniques – Salient features of individual blocks – Applications of ESR. Nuclear magnetic resonance – theory – NMR spectrometer – Principle and working with block diagram– Experimental techniques – Description of individual blocks – Applications of NMR. Mossbauer effect – theory – Mossbauer spectrometer – Principle and working of Mossbauer spectrometer- Experimental methods – Explanation of block diagram– Applications of Mossbauer studies.

UNIT–V: Advanced Spectroscopic and Microscopic Techniques 13 Hrs

Spectroscopic Techniques: Energy Dispersive Spectroscopy, X-ray Photo Electron Spectroscopy, X ray Fluorescence Spectroscopy and Auger Electron Spectroscopy, Secondary Ion Mass Spectrometry.

Imaging Techniques: Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Diffraction Techniques: X-Ray diffraction –Laue method – Powder method.

List of Activities:

1. Assignments
2. Student Seminars

Recommended Books

1. Instrumental methods of Chemical analysis by Chatwal and Anand, Himalaya Publisher, 2003
2. Spectroscopy by B.K. Sarma, Goel publishing House, Meerut, 1993.
3. Spectroscopy Vol I by Straughan and Walker, John Wiley and Sons,1976
4. Molecular Structure and Spectroscopy by G. Aruldas, Prentice Hall ofIndia,2001

Reference Books

5. Introduction to Atomic Spectra, H.E. White, McGraw –Hill Kogakusha. Ltd., New Delhi (1934).
6. Elements of Spectroscopy by Gupta, Kumar, Sarma, Pragati Prakasan, 2012.
7. Spectro chemical Analysis, L. H. Ahrens and S.R. Tayler, Addison-Wesley, London, 1961.
8. Basic principles of Spectroscopy by Raymond Chang, McGraw Hill,1971

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10B: ADVANCES IN PHYSICS

Hours/Week: 6
Credits: 5

Course Objectives: To inspire students with the latest developments in major branches of physics in addressing important societal challenges, using micro,& nano devices, ceramics, functional materials, microcontrollers and application of remote sensing in Environmental Management, Natural resource management.

Course Outcomes
Upon the successful completion of the course, students will be able to:
CO1: Outline the structure and applications of MEMS and Nano devices.
CO2: Explain the types of ceramics, phase diagrams, fabrication and their processing techniques.
CO3: Describe the structure, properties of amorphous semiconductors and polymers, classification and their applications.
CO4: Summarize the basic architecture of microprocessors and microcontrollers, logical instructions, Boolean Variable Manipulation Instructions and their differences.
CO5: Discuss the concepts and systems, sources of remote sensing information, advantages and application of remote sensing in Environmental and naural resource management.

SYLLABUS

UNIT–I: Micro and Nano devices 12Hrs
Introduction to Microelectromechanical systems (MEMS), Basic MEM structure. Applications of MEMS: Pressure sensors, Accelerometers Mass flow sensors.
Nano devices: Quantum well and quantum dot devices: Infrared Detectors –Quantum Dot Lasers. Carbon nanotube emitters - Plasmon’s propagation in wave guides.

Unit-II: Ceramics 12Hrs
Types and Applications – Glasses, Glasss-cermaics, Clay products, Refractories, Abrasives, Cements, Advanced ceramics, Ceramic Phase diagrams; Fabrication and Processing of Glasses and Glass-Ceramics, Fabrication and Processing of Clay Products, Powder Pressing, Tape Casting

UNIT- III: Functional Materials 12 Hrs
Amorphous semiconductors: Band structure – Electronic conduction – Optical absorption – Applications.
Polymers: Classification – Structural property correlation – Molecular weight – Crystalline in polymers – Applications.

UNIT–IV: 8051 Microcontrollers **14 Hrs**

Introduction of Microprocessors and Microcontrollers, Microcontroller: 8051 Internal Architecture, Register Structure, I/O pins, Memory Organization, 8051 addressing modes. 8051 Assembly Language Programming Tools. 8051 Instruction set: Data Transfer Instructions, Arithmetic instructions, Logical instructions, Boolean Variable Manipulation Instructions-Bit Addressability, Single-Bit instructions, Program Branching Instructions-Jump, Loop, and Call instructions, Rotate Instructions, Stack Pointer.

UNIT -V: Remote Sensing **14 Hrs**

Definition of remote sensing; introduction to concepts and systems; Electromagnetic radiation; electromagnetic spectrum; image characteristics; remote sensing systems; remote sensing platform; Sources of remote sensing information; Advantages of remote sensing. Application of Remote sensing in Environmental Management, Natural resource management – forest resources, water resources, land resources and mineral resources.

List of Activities:

1. Assignments
2. Student Seminars

Recommended Books

1. Introduction to Nanotechnology, By Charles P. Poole, Jr and Frank J. Owens, Willey India (2006).
2. An Introduction to Micro electromechanical Systems Engineering by Nadim Maluf, Artech House Publishers, 2004
3. Nanomaterials Synthesis Properties and Applications, by Alen. S.Edelsteinand Robert C. Cammarata, 1998.
4. Floyd F. Sabins Jr., Remote Sensing Principles and interpretation, .H.Freeman and Company, 2^{nd}Ed., New York, 1987.
5. Remote Sensing and Image Interpretation', T.M. Lilles and R.W. Kiefer, John Wiley&Sons, New York, 1994.
6. Material Science & Engineering by V. Raghavan, Prentice Hall of India
7. Material Science and Engineering by Callistar
8. Text Book of polymer science by Gowarikar, Sreedhar and Viswanathan, Wiley-Eastern Publications. India
9. An Introduction to composite materials by Derek Hull, Cambridge University Press, Cambridge, U.K. ((1981)

Reference Books

1. An Introduction to GIS by Ian Heywood et al., Addision Wesley, Longmont Limited, England,2011.
2. Nano structures and Nanomaterials : Synthesis, Properties and application by Guozliong Cao, Imperial College Press (2004).
3. The8051Microcontroller and Embedded systems, by Mahammad Ali Mazidi and Janice Gillispie Mazidi, Pearson Education Asia, Pvt.Ltd.,2000.

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11B: CONDENSED MATTER PHYSICS (Skill Oriented)

Hours/Week: 3
Credits: 3

Course Objectives: To introduce the fundamental concepts and principles, elastic, thermal properties of solids, energy bands and Fermi Surfaces, Ferro and anti- ferromagnetism, photoconductivity and luminescence mechanisms in Condensed Matter Physics.

Course Outcomes
Upon the successful completion of the course, students will be able to:
CO1: Evaluate elastic constants using experimental techniques and discuss their applications.
CO2: Outline the thermal properties of solids using the concept of quantum theory of lattice vibrations, properties of phonons and their role in determining thermal expansion.
CO3: Describe the importance and characteristics of Fermi surfaces in determining Energy band calculations.
CO4: Summarize the basics of ferromagnetism, anti-ferromagnetism, theories and models, used to study these phenomena and their applications.
CO5: Discuss the principles, techniques used to study photoconductivity, various luminescence and their applications.

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UNIT-I: Elastic Properties of Solids **7 Hrs**
Lattice as a homogeneous and continuous medium - Analysis of stress and strain tensors –Hooke's law - Elastic compliances and stiffness constants – Elastic energy density – Cauchy's relations – Bulk modulus and compressibility – Experimental determination of elastic constants – Pulse-echo technique.

UNIT-II: Thermal Properties of Solids **8 Hrs**
Quantum theory of lattice vibrations – Properties of phonons – Lattice specific heat at low temperatures – Einstein and Debye models – Inelastic scattering of neutrons by phonons– Experimental study of dispersion curves – Thermal expansion – Gruneisen parameter- Lattice thermal

UNIT-III: Energy bands and Fermi Surfaces **8 Hrs**
Energy band calculations: Plane Wave method and Augmented Plane Wave (APW) method. Importance of Fermi surface – Characteristics of Fermi surface – Construction of Fermi surface - Experimental study of Fermi surface: Anomalous skin effect –Cyclotron resonance – deHaas van Alphen effect.

UNIT-IV: Ferromagnetism and Anti-ferromagnetism **8 Hrs**

Ferromagnetism: Introduction – Weiss molecular field theory – Temperature dependence of spontaneous magnetization – Heisenberg model – Ferromagnetic domains – Blochwall – Thickness and energy – Ferromagnetic spin waves – Magnons–Dispersion relations.

Anti-ferromagnetism: Introduction of anti-ferromagnetism – Ferrimagnetism - Ferrites – Structure – Applications– Multiferroics.

UNIT-V: Photoconductivity and Luminescence **7 Hrs**

Photoconductivity – Simple model – Influence of traps – Space charge effects – Determination of photoconductivity. Luminescence – Various types–Thermo luminescence, Electroluminescence, Photoluminescence, Cathodoluminescence and Chemiluminescence

List of Activities:

1. Assignments
2. Student Seminars

Recommended Books

1. Solid State Physics, M.A. Wahab, Edition: 3rd, 2020, Narosa Publishing House.
2. Fundamentals of Solid State Physics, Saxena, Gupta, Saxena, Edition: 31st, 2019,Pragathi
3. Solid State Physics, R.L. Singhal, Kedar Nath, RamNath &Co. Publications, Meerut,2018.

Reference Books

1. Solid State Physics, C. Kittel, Edition: 8th 2012, John Wiley & Sons.
2. Solid State Physics, A.J. Dekkar, Edition: 1st, 2000. Macmillan India Ltd.

SEMESTER – VII – Practical Lab Course-1

11-B- LAB-1: Condensed Matter Physics - Practical

Hours/Week: 3
Credits: 2

Course Objectives

To equip, students with experimental skills, by applying the learnt concepts from Condensed Matter Physics.

Course Outcomes

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

CO1: Trace B-H Curve and determine the magnetization properties.

CO2: Obtain the cut-off frequency and the optical band gap of the given materials from the study of Lattice Dynamics.

CO3: Determine the Hall coefficient for the given semiconductor material using Hall effect.

CO4: Measure the magneto resistance of the given semiconductor.

CO5: Evaluate the Curie temperature for the given Ferromagnetic Material.

CO6: Determine the magnetic susceptibility of the given material by Guoy method.

CO7: Determine the Dielectric constant of the given material.

CO8: Measure the resistance of the given semiconductor by four probe method.

CO9: Measure the magnetic susceptibility by Quinke's method.

Any six of the following experiments:

List of Experiments:

1. BH Curve Tracer
2. Lattice Dynamics
3. Hall effect
4. Magneto resistance
5. Curie temperature
6. Magnetic susceptibility Gouy's method
7. Dielectric constant
8. Measurement of Resistance by using four probe method
9. Measurement of Magnetic susceptibility by Quinke's method

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12B: VLSI DESIGN (SKILL)

Hours/Week: 3
Credits: 3

Course Objectives: To introduce students with the fundamental concepts, principles, characteristics of MOSFET, CMOS Logic Networks in VLSI Design and applications.

Course Outcomes
Upon the successful completion of the course, students will be able to:
CO1: Outline the overview of VLSI and Logic Design with MOSFET .
CO2: Describe the physical structure and fabrication, silicon processing for material growth and deposition, lithography using the process flow and design rules of CMOS technology.
CO3: Summarize the basic concepts, electrical characteristics, layout techniques for basic structures, cell concepts, physical design of logic gates and optimization of the performance of MOSFETs.
CO4: Describe the DC & inverter switching, power dissipation characteristics and optimal transient performance of CMOS logic gates.
CO5: Design High-speed CMOS Logic Networks and their functioning.

SYLLABUS

UNIT-I: **An Overview of VLSI and Logic Design with MOSFET** **8 Hrs**
Complexity and Design, Basic concepts, Ideal switches and Boolean operations, MOSFETs as switches, Basic logics gates in CMOS, and Complex logic gates in CMOS

UNIT-II: Physical Structure and Fabrication of CMOS ICs **7 Hrs**
Integrated Circuit layers, MOSFETs, CMOS layers, Designing FET arrays, Overview of silicon processing, Material growth and deposition, Lithography, The CMOS process flow, Design rules.

UNIT-III: **Elements of Physical Design and Electrical Characteristics of MOSFETs** **8 Hrs**
Basic concepts, Layout of basic structures, Cell concepts, FET sizing and the unit transistor, Physical design of logic gates, Design hierarchies, MOS physics, nFET current-voltage equations, FET RC model, pFET characteristics, Modeling of small MOSFETs.

UNIT-IV: **Electronic analysis of CMOS logic gates** **7 Hrs**
DC characteristics of the CMOS inverter, Inverter switching characteristics, Power dissipation, DC characteristics: NAND and NOR gates, NAND and NOR transient response, Analysis of complex logic gates,

UNIT V: Designing High-speed CMOS Logic Networks- **7 Hrs**
Gate delays, Driving Large capacitive loads, Logical effort, BiCMOS drivers.

List of Activities:

1. Assignments
2. Student Seminars

Recommended Books

1. S.K.Ghandhi,“VLSIFabricationprinciples”,2/e,JohnWiley&Sons(Asia)Pte.Ltd.,2003.
2. S.M.Sze,“VLSITechnology”,2/e,McGraw-Hill,1988.
3. YuanTaurandT.H.Ning,“FundamentalsofModernVLSIdevices”,CambridgeUniversity,Press, 1998.

Reference Books

1. John P. Uyemura, “Introduction to VLSI circuits and Systems”, John Wiley & Sons Asia PetLtd., 2003.
2. N.H.E.WesteandK.Eshraghian,“PrinciplesofCMOSVLSIdesign”,PearsonEducation,Inc., 1999.
3. R.L.Geiger,P.E.AllenandN.R.Strader,“VLSIdesignTechniquesforAnalogandDigitalCircuits”, McGraw-Hill, 1990.

SEMESTER – VII – Practical Lab Course-2
12-B- LAB-2: VLSI design - Practical

Hours/Week: 3
Credits: 2
Practical - VLSI design - (Steam B **)**

Course Objectives

To equip, students with experimental skills, by applying the learnt concepts from VLSI design.

Course Outcomes

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

1. Write a VLSI program for verification of Logic Gates
2. Write a VLSI program for verification of T flip flop
3. Write a VLSI program for verification of Full Adder
4. Write a VLSI program for verification of Half Adder
5. Write a VLSI program for verification of Decoder
6. Write a VLSI program for verification of Encoder
7. Write a VLSI program for verification of Demultiplexer
8. Write a VLSI program for verification of Multiplexer
9. Write a VLSI program for verification of R-S flip flop
10. Write a VLSI program for verification of J-K flip flop

13B: Choose a MOOCs SWAYAM/NPTEL Open online Course

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14A: QUANTUM MECHANICS

Hours/Week: 6
Credits: 5
Course Objectives
To provide students with a comprehensive understanding of postulates, Eigen values and Eigen functions, approximate methods, relativistic quantum theory, and quantization of wave fields in Quantum Mechanics.

Course Outcomes
Upon the successful completion of the course, students will be able to:
CO1: Outline postulates of quantum mechanics and the significance of operators
CO2: Describe orbital and spin angular momentum, commutation of operators, eigenvalues and eigen functions of angular momentum and related concepts.
CO3: Explain time independent nondegenerate perturbation, WKB approximation, Quantization & tunneling and time dependent perturbation.
CO4: Discuss the inadequacies of the Klein-Gordon equation, Dirac's relativistic equation, Negative energy states and spin of electrons.
CO5: Summarize the concepts of field, various quantization techniques, quantization of non-relativistic Schrodinger equation, commutation and anti-commutation relations, system of fermions and bosons and creation and annihilation.

SYLLABUS

Unit-I: Postulates of Quantum Mechanics **12 Hrs**
Postulates of quantum mechanics, Eigen values and Eigen functions for finite well and barrier, Simple harmonic oscillator by operator method.

Liner vector space-Ket and Bra notations, Observables as Hermitian operators, Properties of Hermitian operators, Matrix representation of and operator, Unitary transformation.

Unit-II: Angular Momentum **12 Hrs**
Orbital angular momentum – L_x,L_y,L_z, L^2, L_+, L_- operators; Commutation of operators, Eigen functions and Eigen values of J^2 and J_z, Spin angular momentum, Eigen functions and Eigen values of Spin angular momentum and matrices, Addition of angular momenta, Clebsch-Gordon coefficients for J_1=J_2 = ½.

UNIT-III: Approximate Methods **12 Hrs**
Time independent nondegenerate perturbation- Anhormonic oscillator, Variation method-He atom, Harmonic perturbation, WKB approximation- Connecting formulae- Application to potential well and potential barrier, Quantization and tunnelling, Time dependent perturbation, Transition - Harmonic perturbation and Fermi Golden rule.

UNIT-IV: Relativistic Quantum Theory **12 Hrs**

Klein – Gorden equation, Probability current density, Inadequacy of K. G. equation, Dirac's linear equation-plane wave solution; Negative energy states and spin of electrons.

UNIT-V: Quantization of Wave Fields **12 Hrs**

Concept of Field –Method of Canonical Quantization: Lagrangian Formulation of Field, Hamilton Formulation of Field – Second Quantization – Field equation – Quantization of Non-relativistic Schrodinger equation – Commutation and Anti-Commutation Relations, The N-representation-System of Fermions and Bosons– Creation and Annihilation.

List of Activities:

1. Assignments
2. Student Seminars

Recommended Books

1. Quantum Mechanics: G. Aruldas PHI learning private limited Second edition, 2018
2. Quantum Mechanics: S.L. Kakani and H.M. Chandalia Sultan Chand and,SonsFirstEdition,2004
3. Advanced Quantum Mechanics: B.S.Rajput,Pragatiprakasan,2019
4. Quantum Mechanics: V.K. Thankappan, New Age International(P)Ltd.,Publishers,1993
5. ATextbookofQuantumMechanics:P.M.MathewsandK.Venkatesan,Tata McGraw Hill Publishing Company, 2008
6. Quantum Mechanics:S.L.Gupta,V.Kumar,H.V.SharmaandR.C.Sharma, Jai Prakash Nath and Company, 2007

Reference Books

1. Quantum Mechanics: Concepts and Applications by Nouredine Zettili, Wiley, Ed., 2021
2. Introduction to Quantum Mechanics by David J. Griffiths and Darrell F. Schoeter, Third Ed., Cambridge University Press India Pvt Ltd., 2018.
3. An Introduction to Quantum Mechanics, P.T. Mathews McGraw Hill Publishing Company,1974

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15A: APPLIED SPECTROSCOPY

Hours/Week: 6
Credits: 5

Course Objectives

To provide students with knowledge of the principles and applications of the theoretical and practical aspects of various spectroscopic techniques in research fields.

Course Outcomes

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

CO1: Explain crystal and ligand fields, crystal field theory, energy level diagrams, and correlation diagrams for transition metal ions.
CO2: Outline the properties of rare earth ions, Judd-Ofelt theory, radiative and non-radiative processes, and the applications of rare earth doped luminescent materials.
CO3: Describe fluorescence and phosphorescence spectroscopy, normal and resonance fluorescence, non-radiative decay, and time-resolved emission spectroscopy.
CO4: Discuss high-resolution spectroscopy techniques such as laser optogalvanic spectroscopy, matrix isolation spectroscopy, and laser cooling and their applications.
CO5: Summarize the two-photon spectroscopy, selection rules, Photo acoustic spectroscopy and experimental methodology for applications in physics, chemistry, biology, and medicine.

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UNIT - I: Solid State Spectroscopy I – Transition Metal Ions **14 Hrs**

Introduction – Crystal fields and ligand fields-Concept of ligand field – Scope of ligand field theory – ‘d’ and other orbitals (s,p,f) – Quantitative basis of crystal fields – Crystal field theory – Octahedral crystal field potential on the d-wave functions – The evaluation of 10 Dq - Effect of weak field on S, P, D and F terms. Term energy level diagrams – Correlation diagram for d^2 configuration in octahedral coordination – Tanabe-Sugano diagrams for d^2 configuration in octahedral field.

UNIT - II: Solid State Spectroscopy II – Rare Earth Ions **14 Hrs**

Introduction – Intensity of absorption and emission bands – Oscillator strengths – Intra-configurational f-f transitions –Selection rules – Electric and Magnetic dipole transitions – Judd-Ofelt theory and evaluation of Judd-Ofelt parameters – Radiative transition probabilities of excited states of rare earth ions – branching ratios, stimulated emission cross-sections – Non-radiative process – Energy transfer – Possible mechanisms of energy transfer – Resonance energy transfer – Process of IR to visible up-conversion – Applications of rare earth doped luminescent materials.

UNIT-III: Fluorescence and Phosphorescence Spectroscopy **13 Hrs**

Introduction – Normal and Resonance Fluorescence – Intensities of Transitions – Non-radiative decay of fluorescent molecules – Phosphorescence and the nature of the triplet state – Population of the triplet state–Delayed Fluorescence – Excitation spectra – Experimental methods –Emission life time measurements – Time resolved emission spectroscopy – Applications of Fluorescence and Phosphorescence.

UNIT – IV: High Resolution Spectroscopy **12 Hrs**

Introduction – Light detectors – Single photon counting technique – Phase sensitive detectors – Laser optogalvanic spectroscopy – Matrix isolation spectroscopy – Laser cooling and its applications.

UNIT- V: Two Photon Spectroscopy **12 Hrs**

Introduction – two-photon absorption spectroscopy – Selection rules – Expression for the two-photon absorption cross section – Photo acoustic spectroscopy – Experimental methodology and applications to Physics, Chemistry, Biology and Medicine.

List of Activities:

1. Assignments
2. Student Seminars

Recommended Books

1. Molecular spectra and Molecular Structure Vol.I, G. Herzberg, 2^{nd}Ed, Van. Nostrand(1950).
2. Molecular Structure and Spectroscopy G. Aruldhas, Printice-Hall Pvt. Ltd.(2001).
3. Instrumental Methods of Analysis Willard, Merritt, Dean & Settle, CBS Pub, (2001).
4. Spectro chemical Analysis, L.H. Ahrens and S.R.Taylor, Addison Wesley,London,Pergamon,1961.
5. Elements of Spectroscopy, Gupta, Kumar and Sharma Pragati Prakasan, New Delhi (2012).
6. Elements of Diatomic Molecular Spectra, H. Dunford, Addison WeslyPublishingcompany,1965.

Reference Books

1. Principles of Fluorescence Spectroscopy, Joseph R. Lakowicz – Plenum Press, (1983).
2. Fundamentals of Molecular Spectroscopy, C.N. Banwell, Tata Mc Graw-Hill,(1983).
3. Spectroscopy Straughan and Walker (Vol.2 &3),John Wiley&Sons, (1976).

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16A: NUCLEAR AND PARTICLE PHYSICS

Hours/Week: 6
Credits: 5

Course Objectives

The course aims to provide a comprehensive understanding of nuclear forces and models, nuclear reactions and decays, nuclear accelerators and reactors, elementary particles, and cosmic rays.

Course Outcomes

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

CO1: Discuss the characteristics of nuclear forces and the different nuclear models.
CO2: Explain the different types of nuclear reactions, nuclear transformations through nuclear decays, interaction of gamma radiation with matter, Photoelectric effect ,Compton scattering and Pair production.
CO3: Describe the functioning of nuclear accelerators, nuclear reactors and classification.
CO4: Summarize the classification of elementary particles, their interactions, conservation laws, CPT theorem, symmetries, and Quark model.
CO5: Discuss cosmic rays, their origin, high energy interactions, and the interpretation of geomagnetic effects.

SYLLABUS

UNIT– I: Nuclear Forces and Models 12 Hrs

Nuclear Forces: Characteristics of nuclear forces – Ground state of Deuteron – Proton –Proton scattering – Neutron – Proton scattering–Meson theory of nuclear forces.
Nuclear Models: Introduction–The liquid drop model – Bethe-Weizackersemi- empirical binding energy equation and its applications – Nuclear shell model – Energy levels and calculation of angular momentum– Collective model.

UNIT–II: Nuclear Reactions and Decays 14 Hrs

Nuclear Reactions: Types of nuclear reactions – Compound nuclear reactions–Nuclear cross section–Resonance theory– Briet Wigner formula.
Nuclear Decays: Nuclear transformations – Radioactive decay – Alpha decay – Gamow's theory – Beta decay – Fermi theory – Selection rules – Interaction of gamma radiation with matter – Photoelectric effect – Compton scattering – Pair production.

UNIT–III: Nuclear Accelerators and Reactors 12 Hrs

Nuclear Accelerators: Introduction – Linear accelerators – Drift tube and Wave guide accelerators –Low energy circular accelerators – Cyclotron and Betatron – High-energy circular accelerators– Synchrotron and Microtron.

Nuclear Reactors: Nuclear fission and fusion reactions – Nuclear chain reactions – Four factor formula –The critical size of a reactor – General aspects of reactor design – Classification of reactors – Power reactors (elementary aspects only).

UNIT–IV: **Elementary Particles** **13 Hrs**

Discovery and classification of elementary particles–Types of interactions –Conservation laws–Iso-spin, parity, charge conjugation – Time reversal – CPT theorem – Properties of leptons, mesons and baryons – Elementary particle symmetries (SU2 and SU3 symmetries) – Quark model – Search for Higg's particle –elementary ideas.

UNIT-V: Cosmic Rays **12 Hrs**

Introduction, Secondary cosmic rays, geometric effects, Interpretation of geomagnetic effects, Absorption of cosmic rays, Showers, Cosmic ray primaries, high energy nuclear interactions, Extensive air showers, Origin of Cosmic rays.

List of Activities:

1. Assignments
2. Student Seminars

Recommended Books

1. Atomic and Nuclear Physics (Vol.2), S. N. Ghoshal, S. Chand & Co.(1994).
2. Nuclear Physics, D.C.Tayal, Himalaya Pub.(1997).
3. Atomic and Nuclear Physics ,R.C. Sharma, K. Nath & Co.,Meerut(2007).
4. Nuclei and Particles, E.Segre, WABenjamin. Inc.,(1965).

Reference Books

1. Nuclear Physics, Irving Kaplan, Narosa Pub.(1998).
2. Nuclear Physics, Theory and experiment–P.R.Roy and B.P. Nigam, New AgeInt.1997.
3. Introduction to Nuclear Physics, H. A. Enge, Addison Wesley(1975).
4. Introduction to Nuclear Physics, K.S. Krane, John Wiley &Sons(1988).

17A: MICROPROCESSOR & MICROCONTROLLERS (SKILL ORIENTED)

Hours/Week: 3
Credits: 3

Course Objective:

To provide students with the knowledge of Microprocessors and Microcontrollers, their architecture, programming, memory and I/O interface, interrupts and impart practical skills using assembly language programming tools.

Course Outcomes

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

CO1: Describe the internal architecture of microprocessors, memory addressing modes, and instruction sets.

CO2: Create programs for microprocessors and explain hardware specifications.

CO3: Develop interface with memory devices, decode addresses, and explain basic I/O interface concepts.

CO4: Discuss interrupt processing, hardware interrupts, direct memory access, and bus interfaces.

CO5: Outline the internal architecture, and use assembly language programming tools for the 8051 microcontroller

SYLLABUS

UNIT- I: Microprocessors and its Architecture **8 Hrs**

Internal microprocessor architecture, Real mode and protected modes of memory addressing, Memory paging.

Addressing modes - Data addressing modes, program memory – addressing modes, Stack – memory addressing modes.

Instruction Set - Data movement instruction, Arithmetic and logic Instruction, Program control instructions, Assembler details.

UNIT–II: Programming the Microprocessor **8 Hrs**

Modular programming, using the keyboard and video display, Data conversions.

Hardware Specifications - Pin - outs and the pin functions, clock - generator (8284A), Bus buffering and latching, Bus timing, Ready and Wait state, Minimum mode versus maximum mode.

UNIT–III: Memory Interface **8 Hrs**

Memory devices, Address decoding, 8088 and 80188 (8-bit) memory interface, 8086, 80186, 80286 and 80386 (16-bit) memory interface.

Basic I/O Interface - Introducing to I/interface, I/O port address decoding, 8255, 8279, 8254, ADC and DAC (excluding multiplexed display & keyboard display using 8255).

UNIT–IV: Interrupts **7 Hrs**

Basic interrupt processing, Hardware interrupts, expanding the interrupt structure, 8259 APIC. **Direct Memory Access -** Basic DMA operation, 8237 DMA controller. **Bus Interface** –PCI bus.

UNIT–V: 8051 Microcontrollers **8 Hrs**

Introduction of Microprocessors and Microcontrollers, Microcontroller: 8051 Internal Architecture, Register Structure, I/O pins, Memory Organization, 8051 addressing modes. 8051 Assembly Language Programming Tools.

List of Activities:

1. Assignments
2. Student Seminars

Recommended Books

1. K.J.Ayala,"The8086Microprocessor:Programming&InterfacingthePC"PenramInternational Publishing(India) Pvt.Ltd., 1995.
2. DouglasV.Hall,"MicroprocessorsandInterfacing,ProgrammingandHardware",2/e,McGraw Hill, International Edition, 1992.
3. Muhammad Ali Mazidi and Janice Gillispie Mazidi,"The80x86IBMPC and Compatible Computers,(VolumesI&II)". 2/e, Printice–Hall,Inc., 1998.
4. WalterA. Triebel and Avatar Singh, "Software, Hardware and Applications"PHI,1995.

Reference Books

1. Yu Cheng Lin and Glenn A. Gibson, "Microcomputer Systems: The8086/8088 Family Architecture, Programming and Design", PHI,1992.

2. B.B. Brey, “The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486,Pentium and Pentium pro processor architecture, programming and interfacing”, 4/e, PHI,1999.

SEMESTER – VIII – Practical Lab Course-1

17-A- LAB-1: Microprocessor & Microcontrollers - Practical

Hours/Week: 3
Credits: 2

Course Objectives

To equip, students with experimental skills, by applying the learnt concepts from Microprocessor & microcontrollers.

Course Outcomes

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

1. Write a assemble language programming for verification of addition of two numbers
2. Write a assemble language programming of Subtraction of two numbers
3. Write a assemble language programming for verification of Multiplication of two numbers
4. Write a assemble language programming of Division of two numbers
5. Write a Assemble language programming for verification of Decoder
6. Write a assemble language programming for verification of filling memory area
7. Write a assemble language programming for verification of largest number of array
8. Write a assemble language programming for verification of smallest number of array
9. Write a assemble language programming for verification of Factorial of given number
10. Write a assemble language programming for verification of addition of three numbers
11. Write a assemble language programming for verification of key code display
12. Write a assemble language programming for verification of previous digits of the number

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18A: MODERN OPTICS (Skill Oriented)

Hours/Week: 3
Credits: 3

Course Objectives:
To provide students with the knowledge of the interaction of radiation with matter, working principles of lasers and their applications, non-linear optics, holography, Fourier optics, fiber optics, and their applications in modern optics.

Course Outcomes:
Upon the successful completion of the course, students will be able to:
CO1: Explain the interaction of radiation with matter through time-dependent perturbation theory, Quantum electrodynamics, and creation and annihilation operators.
CO2: Describe various concepts of lasers, threshold conditions for laser oscillation, working of various lasers and applications.
CO3: Outline basic principles of non-linear optics, optical mixing, and self-focusing of light guided wave optics and pulse compression.
CO4: Discuss recording and reconstruction of holograms, basics of Fourier optics, and Fraunhofer diffraction.
CO5: Summarize the principles, modes and configuration of optical fibers, fiber materials and fabrication, properties, and applications of optical fibers in communication and medicine.

SYLLABUS

UNIT– I: Interaction of Radiation with Matter **8 Hrs**
Time dependent Perturbation Theory, Electric Dipole interaction-Quantum electrodynamics, -creation and annihilation operators- Fock states-Quantation of the field-Zero Point Energy-Coherent-state description of the electromagnetic field-interaction of radiation with matter.

UNIT–II: Lasers **7 Hrs**
Introduction to lasers – Spontaneous and stimulated emission – Laser beam properties – Einstein coefficients – Population inversion – Pumping schemes – Losses in laser radiation – Threshold condition for laser oscillation – Laser cavity - Q factor– different experimental methods – Ruby laser- He-Ne laser– Argon ion laser– CO_2 laser–Laser applications.

UNIT-III: **Non-Linear Optics** **7 Hrs**
Basic Principles – Origin of optical nonlinearity - Harmonic generation – Second harmonic generation–Phase matching condition–Third harmonic generation– Optical mixing–Parametric

generation of light – Parametric light oscillator – Frequency up conversion – Self focusing of light –Guided wave optics-Pulse compression -Optical solutions.

UNIT–IV: Holography and Fourier Optics **8 Hrs**

Introduction to Holography- Recording and reconstruction of Hologram– Speckle pattern–Frenel and Fourier transform Holography– Applications of Holography- Introduction to Fourier optics – Two-dimensional Fourier transforms – Transforms of Dirac-delta function- Fraunhouffer diffraction

UNIT–V: Fiber Optics **8 Hrs**

Total internal reflection - Optical fiber modes and configuration – Single mode fibers – Graded index fiber structure – Fiber materials and fabrication – Mechanical properties of fibers – Attenuation - Erbium doped fiber amplifiers – Solitons in optical fibers - Block diagram of fiber optic communication system –Applications of optical fibers in communication and medicine.

List of Activities:

1. Assignments
2. Student Seminars
3. Applications related to theory

Recommended Books

1. Lasers and Non-Linear Optics, B. B. Laud, Wiley Eastern Ltd.,1983
2. Optics,E.Hecht,AddisonWiley,1974
3. Laser Fundamentals –By William T. Silfvast. , Cambridge University Press

Reference Books

1. Introduction to Modern Optics, G.R. Fowels,2012
2. LasersandtheirApplications,M.J.Beesly,TaylorandFrancis,1976
3. Optical Fiber Communications,G.Keiser,McGrawHillBook,2000
4. Optical Physics by Stephen G Lipson, Ariel Lipson, Henry Lipson, Cambridge University Press

SEMESTER – VIII – Practical Lab Course-2

18-A- LAB-1: Modern Optics - Practical

Hours/Week: 3
Credits: 2

Course Objectives

To equip, students with experimental skills, by applying the learnt concepts from Modern Optics.

Course Outcomes

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

CO1: Determine the wavelengths of the given light source using Hartmann's Dispersion formula.

CO2: Evaluate the refractive index of a transparent solid bar using Diode Laser.

CO3: Study the bending Losses of light in Optical Fiber.

CO4: Determine the Pitch of Wire Mesh.

CO5: Study electro optic effect in the given crystal.

CO6: Determine the Numerical Aperture of the given Optical Fiber.

CO7: Determine (a) slit width & (b) diameter of wire using Laser.

CO8: Determine wavelength of the given He-Ne Laser by using diffraction grating.

CO9: Determine the wavelength of the given Laser source using a grating and a metal scale.

Any six of the following experiments:

List of Experiments:

1. Hartmann's Dispersion formula
2. Refractive Index of a Transparent Solid Bar using Diode Laser
3. Bending Losses in Optical Fiber
4. Determination of the Pitch of Wire Mesh
5. Electro Optic Effect
6. Numerical Aperture of the given Optical Fiber
7. Laser-Determination of (a) slit width & (b) diameter of wire
8. Determination of wavelength of He-Ne Laser by using diffraction grating
9. Lasers-determination of wavelength with grating and metal scale

19A: Choose a MOOCs SWAYAM/NPTEL Open online Course

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14B: FIBRE OPTICS

Hours/Week: 6
Credits: 5

Course Objectives: To familiarize students with the basics of Fiber Optics technology, its working principle, fiber materials, transmission Characteristics optical sources, detectors, couplers, connectors, amplifiers and optical networks.

Course Outcomes
Upon the successful completion of the course, students will be able to:
CO1: Outline the overview of optical fiber communication.
CO2: Describe the transmission characteristics of optical fibers.
CO3: Discuss the principles of optical sources and detectors and differentiate LEDs from laser diodes.
CO4: Summarize the principles of fiber couplers and connectors.
CO5: Analyze the principles of optical amplifiers and Networks.

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UNIT - I Overview of Optical Fiber Communication: **14 Hrs**
Introduction, Historical development, general system, advantages, disadvantages, and applications of optical fiber communication, optical fiber waveguides, Ray theory, cylindrical fiber (no derivations in article 2.4.4), single mode fiber, cutoff wavelength, mode field diameter. Optical Fibers: fiber materials, photonic crystal, fiber optic cables specialty fibers.

UNIT - II Transmission Characteristics of Optical Fibers: **12 Hrs**
Introduction, Attenuation, absorption, scattering losses, bending loss, dispersion, Intra modal dispersion, Inter modal dispersion.

Unit - III Optical Sources and Detectors: **12 Hrs**
Introduction, LED’s, LASER diodes, Photo detectors, Photo detector noise, Response time, double hetero junction structure, Photo diodes, comparison of photo detectors.

UNIT - IV Fiber Couplers and Connectors: **12 Hrs**
Introduction, fiber alignment and joint loss, single mode fiber joints, fiber splices, fiber connectors and fiber couplers.

UNIT - V Optical Amplifiers and Networks: **14 Hrs**
optical amplifiers, basic applications and types, semiconductor optical amplifiers, EDFA. Optical Networks: Introduction, SONET / SDH, Optical Interfaces, SONET/SDH rings, High – speed light – waveguides.

List of Activities:

1. Assignments
2. Student Seminars

Recommended Books

1. Optical Fiber Communication – Gerd Keiser, 4th Ed., MGH, 2008.
2. Optical Fiber Communications– – John M. Senior, Pearson Education. 3 rd Impression, 2007.

Reference Books

1. Fiber optic communication – Joseph C Palais: 4th Edition, Pearson Education.
2. Introduction To Fiber Optics by Ajoy Ghatak & K. Thyagarajan, Cambridge University Press.

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15B: NANOMATERIALS AND DEVICES

Hours/Week: 6
Credits: 5

Course Objectives: To familiarize students with the fundamental concepts, properties, synthesis methods, bottom –up and top-down approaches, nano carbon clusters, C_{60} structures, nanotubes, design of nanoscale devices and their applications.

Course Outcomes
Upon the successful completion of the course, students will be able to:
CO1: Outline the classification of nanomaterials, quantum confinement and size dependent properties.
CO2: Describe bottom-up and top-down approaches and different methods of synthesizing nanomaterials.
CO3: Discuss the bonding nature, unique properties of new carbon structures, carbon clusters, structure of C_{60}, its properties and applications.
CO4: Summarize the various methods of fabricating carbon nanotubes, graphene, their electrical & Mechanical Properties, and applications.
CO5: Explain the basics of nanoscale devices, their design and fabrication, concept of photolithography, MEMS, single electron transistor, and applications.

SYLLABUS

UNIT-1: Basic Concepts in Nanomaterials **12 Hrs**

Scientific Revolution - Feynman's Vision – Nanoscience – Nanotechnology – Nanomaterials - Classification of Nanomaterials - dimensions, confinement - Surface to volume ratio - Energy at bulk and nanoscale - Nature Nanophenomena- Size dependent variation in Physical- Chemical- Catalytic properties

UNIT–II: Synthesis of Nanomaterials **13 Hrs**
Introduction to Bottom –up and Top-down approaches
Ball milling –Inert Gas condensation – Physical vapor deposition -, Molecular Beam Epitaxy – Sputtering – Pulsed laser Deposition –Chemical vapor deposition - Sol Gel – Hydrothermal Synthesis

UNIT-III: Nano –Carbon **14 Hrs**

Carbon molecules: Nature of the carbon bond –New Carbon structure –carbon clusters –Small carbon clusters –Discovery of C60–Structure of C60and its properties –Synthesis of bucky balls and Applications.

UNIT-IV: Carbon Nano tubes-Graphene **14 Hrs**

Carbon Nanotubes: Fabrication –Structure -Electrical Properties – Mechanical properties – Applications of carbon Nanotubes. Graphene: Fabrication–Structure–Electrical Properties – Mechanical properties –Applications.

UNIT–V: Nano Devices **13 Hrs**

Introduction – Nanofabrication – Photo-Lithography – Pattern transfer – Introduction to MEMS-Single Electron Transistor – Solar Cells – Light Emitting diodes – Gas Sensors – Micro batteries -Field emission display devices – Fuel Cells.

List of Activities:

1. Assignments
2. Student Seminars

Recommended Books

1. Nanomaterials: Synthesis, properties and Applications – Edited by A.S. Edelstein and R.C. Cammarata, Institute of Physics Publishing, 2002.
2. Nano practices from Theory to Applications edited by Gunter Schmid, Wiley VCH, 2004.

Reference Books

1. Introduction to Nanotechnology – Charles P. Poole Jr and Frant J. Owens, Wiley Inter science, 2003.
2. Nano electronics and Nano systems by K. Glosekotter and J. Dienstuthi (Springer), 2004.

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16B: ENERGY STORAGE DEVICES

Hours/Week: 6
Credits: 5

Course Objectives: To familiarize students with the fundamental of different types of energy storage systems, their operating principles, challenges and their applications.

Course Outcomes
Upon the successful completion of the course, students will be able to:
CO1: Identify the current and future needs, opportunities, challenges, benefits of energy storage systems and analyze the current electric vehicle market.
CO2: Describe the types of thermal storage systems and their economic evaluation, types of organic and inorganic materials used for heat storage.
CO3: Discuss chemical method of storing hydrogen, methane, solar energy, and the opportunities and challenges associated with chemical storage systems.
CO4: Analyze the performance of double layer capacitors with electrostatically charged storage and superconducting magnetic energy storage systems.
CO5: Explain the working principles of batteries, super capacitors, fuel cells, and their applications.

SYLLABUS

UNIT I: **Energy storage systems** – **12 Hrs**

Scope of energy storage, needs and opportunities in energy storage, Technology overview and key disciplines, comparison of time scale of storages and applications, Energy storage in the power and transportation sectors. Importance of energy storage systems in electric vehicles, Current electric vehicle market.

UNIT II: **Thermal storage system-** **13 Hrs**

Heat pumps, hot water storage tank, solar thermal collector, application of phase change materials for heat storage-organic and inorganic materials, efficiencies, and economic evaluation of thermal energy storage systems.

UNIT III: **Chemical storage system** **12 Hrs**

Hydrogen, methane etc., concept of chemical storage of solar energy, application of chemical energy storage system, advantages and limitations of chemical energy storage, challenges, and future prospects of chemical storage systems

UNIT IV: **Electromagnetic storage systems** **13 Hrs**

Double layer capacitors with electrostatically charge storage, superconducting magnetic energy storage (SMES), concepts, advantages and limitations of electromagnetic energy storage systems, and future prospects of electrochemical storage systems.

UNIT V: **Electrochemical storage system** **14 Hrs**

(a) Batteries-Working principle of battery, primary and secondary (flow) batteries, battery performance evaluation methods, major battery chemistries and their voltages- Li-ion battery& Metal hydride battery vs lead-acid battery. (b) Supercapacitors- Working principle of supercapacitor, types of supercapacitors, cycling and performance characteristics, difference between battery and supercapacitors, Introduction to Hybrid electrochemical supercapacitors (c) Fuel cell: Operational principle of a fuel cell, types of fuel cells, hybrid fuel cell-battery systems, hybrid fuel cell-supercapacitor systems.

List of Activities:

1. Assignments
2. Student Seminars

Recommended Books

1. Frank S. Barnes and Jonah G. Levine, Large Energy Storage Systems Handbook (Mechanical and Aerospace Engineering Series), CRC press (2011)
2. Pistoia, Gianfranco, and Boryann Liaw. Behaviour of Lithium-Ion Batteries in Electric Vehicles: Battery Health, Performance, Safety, and Cost. Springer International Publishing AG, 2018.

Reference Books

1. Ralph Zito, Energy storage: A new approach, Wiley (2010) 4.
2. Robert A. Huggins, Energy storage, Springer Science & Business Media (2010)

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17B: EMBEDDED SYSTEMS (Skill Oriented)

Hours/Week: 3
Credits: 3

Course Objectives: To familiarize students with the basic principles of embedded systems, their architecture of 16F84A, its hardware details, assembler and assembler programs, and PIC Microcontroller and its applications.

Course Outcomes
Upon the successful completion of the course, students will be able to:
CO1: Compare different embedded systems and their suitability for different applications.
CO2: Explain the architecture, memory organization, timing generation, the power-up and reset functions of the 16F84A microcontroller.
CO3: Demonstrate the knowledge of parallel ports, function of clock oscillators, interrupts, power supply requirements, interrupts, timer and counter of the PIC16F84A.
CO4: Compile simple assembler programs and adopting a development environment.
CO5: Describe the CPU architecture of PIC 16F873A microcontroller, its interface as LED displays, liquid crystal displays, sensors and actuators.

SYLLABUS

UNIT-I: Introduction to Embedded Systems 7 Hrs
Embedded systems in today's world – examples of embedded systems – Microprocessors and Microcontrollers – Microchip and PIC microcontroller – Introduction to PIC microcontrollers using the 12 series.

UNIT –II: Architecture of 16F84A 8 Hrs
Architecture of 16F84A – Memory organization – in 16F84A – Timing generation – Power-up and Reset functions in 16F84A.

UNIT-III: Hardware Details of 16F84A 8 Hrs
Parallel ports: Basic idea – Technical challenge – connecting to the parallel port – Parallel ports of PIC16F84A – Clock oscillator – Power supply – Interrupts – Timers and counters – watch dog timer– Sleep mode.

UNIT-IV: Assembler and Assembler Programs 8 Hrs
Basic idea – PIC 16 series instruction set and ALU – Assemblers and Assembler format –creating simple programs – Adopting a development environment –

UNIT-V: PIC Microcontroller PIC 16F873A **8 Hrs**

Block diagram and CPU – Memory and memory maps – Interrupts – Oscillator, Reset and Power supply – Parallel ports. Comparator and PR2 register–capture/ Compare/ PWM(CCP) Module – Interface: LED displays– Liquid crystal displays – Sensors – Actuators.

List of Activities:

1. Assignments
2. Student Seminars

Recommended Books

1. Microcontrollers: Theory and Applications by Ajay V. Deshmukh, Tata McGraw- Hill, New Delhi, 2005.
2. The 8051 Microcontroller and Embedded systems, by Mahammad Ali Mazidi and Janice Gillispie Mazidi, Pearson Education Asia, Pvt. Ltd., 2000.

Reference Books

1. Designing Embedded Systems with PIC Microcontrollers: Principles and Applications by Tim Wilmshurst, First Edition, 2007, Newnes– Elsevier– Publishers.
2. Designing with PIC Microcontrollers by John B. Peatman, Pearson Education, Inc.,1998.

SEMESTER – VIII – Practical Lab Course-1

17-B- LAB-1: EMBEDDED SYSTEMS - Practical

Hours/Week: 3
Credits: 2

Course Objectives

To equip, students with experimental skills, by applying the learnt concepts from Embedded Systems.

Course Outcomes

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

List of programs (Software)

1. Write a program to add two 8- bit Numbers using PIC Microcontroller 16F877.
2. Write a program to subtract two 8- bit Numbers using PIC Microcontroller 16F877.
3. Write a program to convert Uppercase letter to lowercase letter using PIC Microcontroller 16F877.
4. Write a program to find maximum of two 8- bit numbers using PIC Microcontroller 16F877.
5. Programming with PIC Microcontroller- Buzzer
6. Programming with PIC Microcontroller-Interface

List of programs (Hardware)

1. Interface LED to PIC Microcontroller 16F877.
2. Interface Switch to PIC Microcontroller 16F877.
3. Interface Buzzer to PIC Microcontroller 16F877.
4. Interface Relay to PIC Microcontroller 16F877.

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18B: PHOTONICS (SKILL)

Hours/Week: 3
Credits: 3

Course Objectives: To familiarize students with the principles of Laser systems, properties and applications, fiber optic components and sensors, basics of integrated optics, light modulation, Photonic crystals and optical communications and their applications.

Course Outcomes

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

CO1: Describe the excitation mechanisms and working principles of different types of lasers, and its application as laser isotope separation.
CO2: Explain the principles of fiber optic splices, connectors, optical couplers, switches, fiber-optic isolators, and their applications in fiber optic networks and sensors.
CO3: Outline the principles and functioning of waveguides, integrated photo diodes, edge and surface emitting lasers and their applications.
CO4: Demonstrate the knowledge of optic, acousto-optic, magneto-optic modulation, and advantages of optical modulation.
CO5: Describe the basics, features, theoretical modeling, fabrication methods of photonic crystals, their applications in optical communications and as sensors.

SYLLABUS

UNIT–I: Laser systems, Properties and Applications **8 Hrs**

General description, structure, excitation mechanism and working of CO_2, Argon ion, laser Nd:YAG, Optical parametric oscillator, semiconductor and erbium doped fiber lasers. Q-Switching- Laser applications in isotopic separation.

UNIT- II: Fiber Optic Components and Sensors **8 Hrs**

Connector principles, Splices, Connectors, Source coupling, Directional couplers, Star couplers, Switches, Fiber optical isolator, Wavelength division multiplexing, Time division multiplexing, Fiber Bragg gratings- Fiber optic sensors, Intensity modulated sensors, Current sensors, Chemical sensors –Fiber optic rotation sensors.

UNIT- III: Integrated Optics **7 Hrs**

Introduction – Planar wave guide – Channel wave guide – Y-junction beam splitters and couplers – Prism and grating couplers – Lens waveguide– Integrated photodiodes – Edge and surface emitting laser – Distributed Bragg reflection and Distributed feedback lasers

UNIT – IV: **Modulation of Light** **8 Hrs**

Introduction, Birefringence, Electro-optic effect, Pockels and Kerr effects, Electro-optic phase modulation, Electro-optic amplitude modulation, Electro-optic modulators: scanning and switching, Acousto-optic effect, Acousto-optic modulation, Magneto-optic effect, Advantages of optical modulation.

UNIT-V: Photonic Crystals **7 Hrs**

Basics concepts, Theoretical modeling of photonic crystals, Features of photonic crystals, Methods of fabrication, Photonic crystal optical circuitry, Nonlinear photonic crystals, Photonic crystal fibers, Photonic crystals and optical communications, Photonic crystal sensors.

List of Activities:

1. Assignments
2. Student Seminars

Recommended Books

1. Laser fundamentals, W. T. Silfvast, Foundation books, New Delhi, 1999.
2. Introduction To Fibre Optics, A. Ghatak And K. Thyagarajan, Cambridge University Press, New Delhi, 1999
3. Optical Guided Wave Signal Devices, R.SymsAndJ.Cozens. Mcgraw Hill, 1993.
4. Optical Electronics, A Ghatak and K.Thyagarajan, Cambridge University Press, New Delhi,1991
5. Nanophotonics, P.N. Prasad, Wiley Interscience, 2003.

Reference Books

1. Lasers: Principles and applications by J. Wilson and J.F.B. Hawkes, Prentice, Hall of India, New Delhi, 1996
2. Fiber Optic Communication, Joseph C. Palais, Pearson Education Asia, India, 2001
3. Fundamentals of Photonics, B.E.A. Saleh and M.C. Teich, John Willy and Sons,1991

SEMESTER – VIII – Practical Lab Course-2

18-B- LAB-2: Photonics - Practical

Hours/Week: 3
Credits: 2

Course Objectives

To equip, students with experimental skills, by applying the learnt concepts from Photonics.

Course Outcomes

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

CO1: Determine the wavelengths of the given light source using Hartmann's Dispersion formula.

CO2: Evaluate the refractive index of a transparent solid bar using Diode Laser.

CO3: Study the bending Losses of light in Optical Fiber.

CO4: Determine the Pitch of Wire Mesh.

CO5: Study electro optic effect in the given crystal.

CO6: Determine the Numerical Aperture of the given Optical Fiber.

CO7: Determine (a) slit width & (b) diameter of wire using Laser.

CO8: Determine wavelength of the given He-Ne Laser by using diffraction grating.

CO9: Determine the wavelength of the given Laser source using a grating and a metal scale.

Any six of the following experiments:

List of Experiments:

1. Hartmann's Dispersion formula
2. Index of a Transparent Solid Bar using Diode Laser
3. Bending Losses in Optical Fiber
4. Determination of the Pitch of Wire Mesh
5. Electro Optic Effect
6. Numerical Aperture of the given Optical Fiber
7. Lasers-determination of wavelength with grating and metal scale
8. Laser-Determination of (a) slit width & (b) diameter of wire
9. Determination of wavelength of he-Ne Laser by using diffraction grating

19A: Choose a MOOCs SWAYAM/NPTEL Open online Course

A.P. State Council of Higher Education
Semester wise Revised Syllabus under CBCS 2020-21
Four Year – B.Sc. (Hons),
Domain Subject: PHYSICS

B.Sc. PHYSICS Honours (For Mathematics combinations) w.e.f. 2020-21

MODEL QUESTION PAPER COMMON FOR ALL FIVE THEORY COURSES

Time : 3 hrs   Max marks : 75

SECTION-A

(Essay Type Questions)   Marks: 5x10M = 50M

Answer All questions with internal choice from each Unit

1. Essay type question from Unit-I
   Or
   Essay type question from Unit-I

2. Essay type question from Unit-II
   Or
   Essay type question from Unit-II

3. Essay type question from Unit-III
   Or
   Essay type question from Unit-III

4. Essay type question from Unit-IV
   Or
   Essay type question from Unit-IV

5. Essay type question from Unit-V
   Or
   Essay type question from Unit-V

SECTION-B

(Short Answer Type Questions)   Marks: 5x 5M = 25M

Answer any **five** out of the following ten questions

6. Short answer type question from Unit-I
7. Short answer type question from Unit-I
8. Short answer type question from Unit-II
9. Short answer type question from Unit-II
10. Short answer type question from Unit-III
11. Short answer type question from Unit-III

12. Short answer type question from Unit-IV
13. Short answer type question from Unit-IV
14. Short answer type question from Unit-V
15. Short answer type question from Unit-V

Co-curricular activities - Common to all Courses

1. An assignment on a related topic of the course taken and submit.
2. A debate on a related topic of the course taken.
3. A visit to a nearby school and demonstrate a simple experiment related to their syllabus.
4. A seminar using power point presentation / a self-made video / Video from OER on a related topic of the course taken.
5. Design a working / physical model related to a particular concept of the course taken and submit.
6. Design experiments related to a particular concept of the course taken using cost effective locally available materials and submit.
7. Learn a simulation experiment on a particular concept of the course taken and submit.
8. Write a C programme for solving a problem.
9. Write a C programme for taking input and output of an experiment.
10. Draw a graph using Excel for the data of an experiment.
11. Solve problems using MATLAB/ SCILAB.
12. Create a simulation for an experiment using MATLAB/SCILAB.
13. Identify a research paper on a topic related to the course taken.
14. Identify a research paper on the recent research trends of the course taken.
15. Create content on a topic related to the course using CHATGPT and analyze it.
16. A visit to relevant industry and submit a report.
17. A visit to University laboratories and submit a report.
18. A visit to virtual labs and collect related experiments relevant to the course and submit a report on any one experiment.
19. A virtual visit to CERN lab, learn the latest research trends and submit a report on any one idea.
20. Short term online courses related to the course under study and submit the certificate of completion.(Maximum five hours)
21. Attend National / International conferences /workshops etc.,
22. Attend DST supported summer and winter schools for gaining more ideology related to research
23. A visit to an Electronic Instrumentation center and submit a report.
24. A visit to Super Specialty Hospital and submit a report on any one diagnosis technique and the working of that instrument.