Semester IV

Paper Code	Paper No	Paper Name	Credit
	C12	Atomic, Molecular & Laser Physics	3+0+1
	SPL2		5
	OPE2		4
	DPW	Dissertation & Project Work	6

Special Papers: (Credit 5)

For SEM-IV (SPL-2): Any one from the following list

Paper Code	Paper No	Paper Name	Credit
	SPL2-1	High Energy Physics –II	4+1+0
	SPL2-2	Nuclear Physics	3+1+1
	SPL2-3	Thin Film Physics	4+1+0

Open Elective (Interdisciplinary): (Credit 4)

For SEM-IV (OPE-2): Any one from the following list

Paper Code	Paper No	Paper Name	Credit
	OPE2-1	Introduction to Astronomy & Astrophysics II	3+1+0
	OPE2-2	Biophysics	3+1+0
	OPE2-3	Opto Electronics	3+0+1
	OPE2-4	Physics of Materials	3+1+0
	OPE2-5	Plasma Physics	3+1+0

Paper Code: **Paper No: C12**

Paper Name: Atomic, Molecular & Laser Physics

Credit: 3+0+1

Theory: 48 Lecture

Atomic Physics:

Fine structure of hydrogen atoms – Mass correction, spin-orbit term, Darwin term, Intesity of fine structure lines. The ground state of two-electron atoms – perturbation theory and variation method. Many-electron atoms - LS and jj coupling schemes, Zeeman effect; Paschen-Bach effect; Stark effect, Lande interval rule. The idea of Hartree-Fock equation. The spectra of alkalis using quantum defect theory. Selection rules for electric and magnetic multiple radiations. Oscillator strengths and the Thomas-Reiche-Kuhn sum rule.

(14 Lectures)

Molecular Spectra:

Born-Oppenheimer approximation, rotation, vibration and electronic structure of diatomic molecules, molecular orbital and valance band methods for $+H_2$ and H_2. Correlation diagrams for heteronuclear molecules. Heterogeneous molecules: correlation diagrams; polyatomic molecules and their structure.

(12 Lectures)

Rotation, vibration-rotation and electronic spectra and Raman spectra selection rules. Resonance; nuclear magnetic resonance; chemical shift. The Frank-Condon principle. The electroc spin and Hund's rule. Idea of symmetry elements and point groups for diatomic and polyatomic molecules.

(10 Lectures)

Lasers:

Spontaneous and stimulated emission; Einstein A & B coefficients, Multilevel rate equations and saturation. Rabi frequency . Laser pumping and population inversion. Modes of resonators and coherence length, He-Ne Laser, Solid State Laser, Free-electron laser, Non-linear phenomenon. Harmonic generation. Laser accelerator, liquid and gas lasers, semiconductor lasers.

(12 Lectures)

List of Experiment: (1 Credit, 16 classes of 2 hours duration)

1. Fine structure of H or Hg using spectrometer
2. Frank & Hertz experiment
3. Raman scattering using laser

4. Band spectra
5. Zeeman Effect

(More Experiments will be added later by the department)

(Aim of the experiments will be modified according to the availability of infrastructure facility)

Reference Book:

1. Physics of Atoms and Molecules by B H Bransden and C J Jochain, Pearson Education
2. Atomic Physics by C J Foot Oxford Univ. Press
3. Atoms, Molecules and Photons by W Demtroder, Springer
4. Molecular Spectra and Molecular Structure by G Herzberg, Van Nostrand
5. Basic Atomic & Molecular Spectroscopy by J M Hollas, Royal Society of Chemistry
6. Laser Spectroscopy by W Demtroder, Springer
7. Molecular Physics by W Demtroder, Wiley-VCH

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Special Papers For SEM-IV (SPL-2):

Paper Code: Paper No: SPL2-1

Paper Name: High Energy Physics-II

Credit: 4+1+0

Theory: 64 Lecture

General concepts of Gauge Theories: (20Lectures)

Gauge theories of interaction, Abelian and Non-Abelian gauge theories, local and global invariance in gauge theories, Yang-Mills Theory.

Standard Model: SU(2)xU(1) electroweak theory, 2 component left handed fermions, weak and charged neutral currents, Spontaneous symmetry breaking, Goldstone theorem and Goldstone bosons, SU(2)XU(1) symmetry breaking via Higgs mechanism, masses of vector bosons.

Quantum Electro-Dynamics: (16Lectures)

Interacting fields: Interaction representation, Normal and time ordered products, Wick's theorem.

Feynman diagrams and rules in QED, Calculation of QED first and second order processes, Mott scattering, Compton scattering, renormalization of charge and mass.

Electrodynamics of quarks and hadrons: (16Lectures)

Elastic electron-muon scattering, electron positron annihilation to hadrons, elastic e -p scattering and concepts of form factors and charge radii, deep-inelastic scattering and structure function, Parton model, Bjorken scaling and its violation, Elementary ideas of QCD evolution equations.

Beyond standard model: (12Lectures)

Introductory ideas on grand unified theories (GUTs). SU(5) model and proton decay possibilities, neutrino puzzles, neutrino oscillations and neutrino masses.

Reading List:

1. Introduction to Elementary Particles: David Griffiths
2. Quarks and Leptons: An Introductory Course in Modern Particle Physics: Francis Halzen & Alan D. Martin
3. Gauge Theory of Elementary Particle Physics: Ta-Pei Cheng & Ling-Fong Li
4. Quantum Field Theory: L. H. Ryder
5. Relativistic Quantum Mechanics (Vol-I & Vol-II): James D. Bjorken & Sidney D. Drell

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Paper Code: Paper No: SPL2-2

Paper Name: Nuclear Physics

Credit: 3+1+1

Theory: 48 Lecture

Nuclear Model

i. Shell model: Independent particle model, total spin J for various configurations, configuration mixing, electric dipole and quadrupole moments of various nuclei in the light of extreme single particle shell model.

ii. Collective model: Failure of shell model in understanding the excited states of even-even nuclei, dynamics of collective motion, rotational and vibrational modes, Hamiltonian for collective model of a deformed nucleus -- Nilsson model. **(6 Lectures)**

Nuclear Excitation and Decay

i. Nuclear transition matrix elements, electromagnetic interaction of nuclei, multi-pole expansion, transition probability, angular momentum and parity, selection rules, nuclear isomerism, internal conversion, internal pair-creation, angular correlation.

ii. Weak interaction and beta decay, transition rate for beta decay, neutrino mass measurement, polarization of electron and neutrino helicity, two component theory of neutrino, parity violation in weak interactions.

(6 Lectures)

Nuclear Instrumentation

Linear accelerator -- tandem and pelletron, variable energy cyclotron, radioactive ion beam,

detectors -- photographic emulsion, solid state nuclear track detectors.

Data acquisition techniques: pre-amplifier, pulse shaping networks in amplifiers, time to amplitude converter (TAC), analogue to digital converter (ADC). **(12 Lectures)**

Fission and Fusion:

i. Characteristics of fission, fission cross-section, spontaneous fission, mass and energy distribution of fission fragments, slowing down of neutrons, rate of energy loss due to successive collisions, Fermi age equation

ii. Particle and nuclear interaction in the early universe, primordial nucleosynthesis, basic fusion processes, characteristics of fusion, stellar nucleosynthesis, s-process and r-process ($A < 60$ & $A > 60$)

(16 Lectures)

Applications of Nuclear Physics

The technique of NMR, some experiments using NMR; the Mossbauer effect, some

experiments on Mossbauer effect. **(4 Lectures)**

Cosmic rays:

Source, origin, cosmic ray showers, experiments on cosmic rays. **(4 Lectures)**

List of Experiments:

1. To determine efficiency of a GM counter
2. To determine the dead time of a GM counter
3. To determine radon concentrations in air, soil and water using AlphaGuard.
4. To determine radionuclides in soil and rocks using gamma spectrometer.

Reading List:

1. Nuclear Physics: Roy and Nigam
2. Introduction to Nuclear Reactions: G. R. Satchler
3. Structure of the Nucleus: M. A. Preston & R. K. Bhaduri
4. Nuclear Physics -- Principles and Applications: John Lilley
5. Nuclear Physics -- Experimental and Theoretical: H. S. Hans
6. Nuclear Physics (Vol. I, II, III): E. Segri
7. Nuclear and Particle Physics: W. E. Burcham & M. Jobes
8. Introductory Nuclear Physics--Kenneth S. Krane: Willey Publications

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Paper Code: **Paper No: SPL2-3**

Paper Name: Thin Film Physics

Credit: 4+1+0

Theory: 64 Lecture

Introduction: **(8 Lectures)**

Thin film, importance of thin film, Nucleation and Growth, Film Formation, Growth modes and Zone models.

Film Deposition Methods: **(10 Lectures)**

o Physical methods of films deposition:

Evaporation – thermal, e-beam

Sputter Deposition - DC, MF, RF, Microwave, pulsed laser, Ion Beam

Arc Deposition – Cathodic, Anodic

Molecular Beam Epitaxy

o Chemical methods of Film deposition: **(8 Lectures)**
Deposition of Inorganic Films From Solutions
Chemical Vapor Deposition - Electrolysis, Anodization, Spray pyrolysis, polymerization

o Other techniques: **(6 Lectures)**
Langmuir Blodgett, Self-Arrangement Monolayer and Spin Coating

Properties of Thin Films: (10 Lectures)
Optical properties, electrical properties, conductivity in thin films, magnetic properties, mechanical properties.

Thin Film Characterization: (12 Lectures)
Imaging Techniques, Structural Techniques, Chemical Techniques, Optical Techniques, Electrical / Magnetic Techniques, Mechanical Techniques.

Applications for Thin Film of Advanced Materials: (10 Lectures)
Transparent conducting coating, Optical coating, Sensors, Superconductivity, Giant and colossal magnetoresistance, Superhard coatings, Ferro-electronic effect.

References:

1. Thin Film Phenomena - K L Chopra, McGraw-Hill.
2. Thin Film - Ashok Goswami, New Age Intl., India.
3. Thin Film Deposition: Principles and Practice, Donald L. Smith, McGrawHill, Singapore.
4. Plasma techniques for film deposition, Konuma Mitsuharu, Alpha Science, Harrow, UK.
5. Introduction to surface and thin film processes, John A. Venables, Cambridge : Cambridge University Press.
6. An introduction to physics and technology of thin films, Alfred Wagendristel, Yuming Wang, Singapore : World Scientific.
7. Thin film processes, John L Vossen, Werner Kehn editors, Academic Press, New York.
8. Thin film physics, O.S. Heavens, London : Methuen.

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Open Elective For SEM-III (OPE-1):

Paper Code: **Paper No: OPE1-1**

Paper Name: Introduction to Astronomy & Astrophysics II

Credit: 3+1+0

Theory: 48 Lectures

Sun:

Physical Characteristics of Sun - Basic Data, Solar Rotation, Solar Magnetic Fields, Photosphere - Granulation, Sunspots, Babcock Model of Sunspot Formation, Solar Atmosphere - Chromosphere and Corona, Solar Activity – Flares, Prominences, Solar Wind, Activity Cycle, Helioseismology. (**6Lectures**)

Stellar Pulsation:

Observations of Pulsating Stars, The Period-Luminsoty Relation, The Instability Strip, The Physics of Stellar Pulsation - The Period-Density Relation, Radial Modes of Pulsation, Eddingtin's Thermodynamic Heat Engine, Opacity Effects and the Kappa and Gamma Mechanisms, The Hydrogen and Helium Partial Ionization Zones. (**6Lectures**)

Physics of Compact Objects:

The End Point in Stellar Evolution, Supernova - Type I and Typen II Supernova, The Physics of Degenerate Stars - The Pauli Exclusion Principle and Electron Degeneracy, White Dwarfs, Classes of White Dwarfs, Chandrasekhar's Mass limit and Mass-Radius Relations for White Dwarfs, Neutron Stars - Neutron Degeneracy, Pulsars, The Maximum Mass of Neutron star, Tolman-Oppenheimer-Volkof Equation, Black Holes and Gamma Ray Bursts. (**12Lectures**)

Galaxies:

Classification of Galaxies and Their Properties, Active Galatic Nuclei and Their Classification, The Milky Way Galaxy: Structure, Content, Rotation, Kinematics, Stellar Populations, Surface Brightness - Isophotes abd the de Vaucouleurs Profile, The Rotation Curves of Galaxies, Dark Matter, The Tully-Fisher Relation, Mass-to-Light Ratios. (**12Lecture**)

Large-Scale Structure of the Universe:

Cosmic Microwave Background Radiation, Expansion of the Universe: The Cosmological Context, The Proper Distance, The Luminosity Distance, The Redshift-Magnitude Relation, Cosmological Distance Ladder, Standard Candles, Measurement of Distances: Cepheid Distance Scale and the Underlying Physics, Main Sequence Fitting, Tully-Fisher Relation, Type Ia Supernova, The Hubble Constant and Age of the Universe, Cosmological Models. (**12Lectures**)

Reference Books:

An Introduction to Modern Astrophysics - Bradley W. Carroll and Dale A. Ostlie

1. An Introduction to the Study of Stellar Structure - S. Chandrasekhar
2. The Physical Universe: An Introduction to Astronomy - Frank H. Shu
3. Physics of Stars - A C Phillips
4. Introduction to Stellar Astrophysics (Vol I, II and III) - Erika Bohm-Vitense
5. An Introduction to Astronomy and Astrophysics - Pankaj Jain
6. Astrophysics for Physicists - Arnab Rai Choudhuri
7. Fundamental Astronomy - H. Karttunen et al.
8. Introduction to Stellar Astrophysics - D Prialnik
9. Galactic Astronomy - J. Binney and M. Merrifield
10. Solar Astrophysics – P. V. Foukal

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Paper Code: Paper No: OPE2-2

Paper Name: Biophysics

Credit: 3+1+0

Theory: 48 Lectures

Aim and Objective

This course aims to bridge the gap between basic physics and '*Physics of life*'. It provides a basic knowledge on the application of physical principles of Thermodynamics and Statistical Mechanics in biological systems. The contents of the course will aid students to understand molecular structure, their behavior and different biological processes.

Pre-requisite: A basic knowledge in biology is desirable, though not mandatory, to credit this course.

Syllabus:

Introduction to bio-macromolecules [4 Lectures]

Proteins, DNA, RNA, lipids and carbohydrates.

Applications of equilibrium and non-equilibrium Statistical Thermodynamics in Biology [8 lectures]

Definition of equilibrium, steady state, out of equilibrium systems, enthalpy, entropy, free energy and their applications in biology, protein folding, protein aggregation.

Chemical kinetics in Biology [8 lectures]

Law of mass action, catalysis and enzymes, Michaelis–Menten (M.M.) kinetics, Inhibition, Allostery .

Transport phenomena in Biology [8 lectures]

Diffusion, anomalous diffusion, phase transition, polymer translocation, ion channels, molecular motors

Life at low Reynolds number [7 lectures]

Scallop theorem, Reciprocal deformation, swimming of microorganisms, mechanism of propulsion

Pattern formation in Biology [8 lectures]

Order in space & time, instabilities, Turing patterns

Molecular dynamics of macromolecules [5 lectures]

Molecular mechanics ; free energy calculations; conformational sampling; Issues in protein structure prediction

Recommended Texts:

1. Molecules of life – Physical and Chemical principles by J. Kuriyan, B. Konforti and D. Wemmer, Taylor and Francis (2013)
2. Molecular driving forces: Statistical Thermodynamics in Chemistry and Biology by K. Dill and S. Bromberg, Garland Science (2010)
3. Biological Physics: Energy, Information, Life by P. Nelson, W.H. Freeman & Co. (2007)
4. Physical biology of the cell by Rob Phillips, Jane Kondev, Julie Theriot, Hernan G.Garcia, Garland Science (2013)

Reference(s):

- **Principles of Physical Biochemistry** by K. E. van Holde, W. C. Johnson and P. S. Ho, , Prentice Hall, 1998.

- **Biophysics: Searching for Principles** by W. Bialek
- **Life at Low Reynolds Number**, E.M. Purcell, *Am. J.Phys*, **45,** 3-11,1977.

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Paper Code: Paper No: OPE2-3

Paper Name: Opto Electronics

Credit: 3+0+1

Theory: 48 Lectures

Basic Optics: **[6 lectures]**

Natural, artificial and specialized light sources, characterization of light sources based on intensity spectrum, emission, spatial distribution, conversion efficiency. Experimental methods for studying these characteristics; Use of optical filters, their disadvantages and necessity and use of monochromatic source, wave nature of light, reflection and refraction, Snell's law, Total Internal Reflection.

Light Sources: **[6 lectures]**

Study of LEDs: variable band-gap semi material idea of hetero-junction, simple and double hetero structure light sources, quantum efficiency, internal and external quantum efficiency, expression for total and internal quantum efficiency, reasons for external quantum efficiency to be less than internal quantum efficiency, intensity distribution of LED, Lambertial sources, encapsulation of LEDs, types of LED surfaces and edge emitting, Burus LED.

Study of LASER: **[6 lectures]**

LASER as an amplifier of light and necessary conditions for amplification, special properties of laser: monochromatic, coherent and light power nature, directionality, divergence and attenuation of LASER beams. Study of 3-level LASER (Ruby LASER), study of 4-level LASER, study of tunable LASER, semiconductor LASER and application of high power, low power continuous wave and pulsed LASERs.

Light Detectors: **[6 lectures]**

Idea of light detectors and their basic types, natural and specialised light detectors, type of specialised light detectors, thermal, quantum light detectors, types of quantum photodetectors, photo-resistive, photo-voltaic, photo-emissive detectors. Study of quantum detectors -- photo-electric cell, photo-multiplier tube, photo-diode, Important characteristics of light detectors -- spectral response, viewing angle, efficiency and material used for photo-detectors.

Optical Fibre: Theory and Applications: **[12 lectures]**

Action of optical fibre as wave guide, advantages of optical fibre communication over normal medium, necessary conditions for wave-guiding mechanisms of optical fibres. Step index and graded-index fibres, expression for angle of acceptance and cone of acceptance, Numerical aperture, time dispersion, splicing and fibre connections -- requirements of splicing, practical methods of splicing; Types of optical fibre connectors, losses in optical fibre communication. Losses due to fibres: intrinsic and extrinsic losses, intrinsic losses due to atomic scattering and molecular absorption, expression for loss factor. Extrinsic losses due to mechanical effects, micro bends, cracks etc. Losses due to connectors, core longitudinal, angular misalignment, mismatch of rate indices of fibre material etc. Expression for electromagnetic wave guided by fibre, modes of transmission, dispersion in optical fibres, wavelength and time dispersion, internodes dispersion

Optical Fibre Systems and Devices: **[8 lectures]**

Optical transmitter/receiver circuits, driver circuits for LED, detector circuit design using photo- diode, photo transistors and fibre choice. Communication over special fibres, DS fibres, NZDS fibre, integrated optics, slab and strip waveguides and electro-optic devices -- phase shifters, interferometer modulators.

Opto-electronic modulation and switching devices: analog and digital modulation, electrooptic modulators, optical switching and logic. Opto-electronic integrated circuits.

Measurement on Optical Fibre: **[4 lectures]**

Optical fibre experimental set-up, launching light into fibre, detection etc. Fibre attenuation measurement, dispersion measurement, profile measurement, numerical aperture measurement, diameter measurement.

Optoelectronics Lab:

Experiments [Any 5 experiments to be performed]

1. Study of characteristics of:
   i. Photo-diode
   ii. Photo-transistor
2. Study of characteristics of
   i. LDR
   ii. LED
3. Study of characteristics of a solar cell
4. Studies of
   i. Analog signal transmission through fibre
   ii. Digital signal transmission through fibre
5. Study of fibre optics voice communication through fibre with different bending losses
6. Study of Splice loss in fibre optics
7. PC-to-PC communication using RS232 port over fibre
8. Transmission of modulated signal through optical fibre and its demodulation
9. Time division multiplexing and demultiplexing through optical fibre
10. Study of Gaussian nature of LASER beam and evaluation of beam spot-size

Reading List:

1. Optical Electronics: A. K. Ghatak & K. Thyagarajan
2. An Introduction to Fibre Optics: A. K. Ghatak & K. Thyagarajan
3. Semiconductor Optoelectronic Devices: P. Bhattacharya
4. Optoelectronics and Fibre Optics Communication: C. K. Sarkar & D. C. Sarkar
5. Fibre Optics Essentials: A. K. Ghatak & K. Thyagarajan

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Paper Code: Paper No: OPE2-4

Paper Name: Physics of Materials

Credit: 3+1+0

Theory: 48 Lectures

CHARACTERISATON OF MATERIALS: Thermo-gravimetric analysis (TGA), differential thermal analysis (DTA), cooling curves, differential scanning calorimetry (DSC), determination of thermo-mechanical parameters. Bright field and Dark field optical microscopy, phase contrast microscopy, confocal microscopy, scanning probe microscopy (SPM), STM, AFM. SEM, EDAX, EPMA, TEM, UV-Vis-IR absorption, Photoluminescence, electroluminescence, thermoluminescence. Two probe and four probe methods, van der Pauw method, C-V characteristics, Schottky barrier capacitance, electrochemical C-V profiling. FTIR spectroscopy, Raman spectroscopy, ESR, NMR, Nuclear quadrupole resonance (NQR) spectroscopy, XPS, AES and SIMS, Proton induced X-ray Emission spectroscopy (PIXE), Rutherford Back Scattering (RBS). **(14 Lectures)**

MECHANICAL PROPERTIES: Factors affecting mechanical properties - mechanical tests - tensile, hardness, impact, creep and fatigue - Plastic deformation by slip, shear strength, work hardening and recovery, fracture , creep resistant materials, Fick's law. **(6 Lectures)**

DIELECTRIC PROPERTIES: Dielectric constant and polarizability, different kinds of polarization, Internal electric field in a dielectric, Clausius-Mossotti equation, dielectric in dc & ac field, dielectric loss, ferroelectric - types and models of ferro electric transition, piezoelectric and pyroelectric materials. **(7 Lectures)**

MAGNETIC PROPERTIES: Dia, para, ferro, antiferro and ferrimagnetism, Langevin and Weiss theories, exchange interaction, magnetic aniostrophy, magnetic domains, molecular theory, hysteresis, hard and soft magnetic materials, ferrite structure and uses, magnetic bubbles, magnetoresistance - GMR materials, dilute magnetic semiconductor (DMS) materials. **(7 Lectures)**

OPTICAL PROPERTIES: Optical absorption in insulators, semiconductors and metals – band to band absorption, luminescence, photoconductivity. Injection luminescence and LEDs - LED materials, super luminescent LED materials, liquid crystals - properties and structure, liquid crystal displays, comparison between LED and LC displays.

(6 Lectures)

TECHNOLOGICAL MATERIALS: Metallic glasses - preparation, properties and applications, SMART materials, piezoelectric, magnetostrictive, electrostrictive materials, shape memory alloys, rheological fluids, CCD device materials and applications, solar cell materials (single crystalline, amorphous and thin films), surface acoustic wave and sonar transducer materials and applications, introduction to nanophase materials and their properties.

(8 Lectures)

REFERENCE BOOKs:

1. Growth and Characterization of semiconductors, Stradling, R.A; Klipstain, P.C; Adam Hilger, Bristol,1990.
2. Electron microscopy and microanalysis of crystalline materials, Belk, J.A; Applied Science Publishers, London, 1979.
3. Electron and Ion microscopy and Microanalysis principles and Applications,Lawrence E.Murr, Marcel Dekker Inc., New York, 1991
4. Analytical Chemistry, D.Kealey & P.J.Haines, Viva Books Private Limited, New \ Delhi 2002.
5. Materials Science and Engineering, V.Raghavan, Prentice Hall,2003.
6. Superfludity and superconductivity, D.R.Tilley and J.Tilley, 3rd Edition, Hilger,1990.
7. Introduction to solid state physics, Charles Kittel, Wiley 7th edition, 1996.
8. Principles of solid state physics, K.V.Keer, Wiley - Eastern, 1993.
9. Microelectronic Materials - C.R.M.Grovenor, Adam Hilger, Bristol and Philadelphia,1989.

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Paper Code: **Paper No: OPE2-5**

Paper Name: Plasma Physics

Credit: 3+1+0

Theory: 48 Lectures

Introduction: **[10 lectures]**

Recap of non-relativistic dynamics of charged particles in electro-magnetic field; plasma as the 4th state of matter; electron and ion temperature; Debey length; cyclotron frequency; Larmour radius; drift velocity of guiding center; magnetic moment; magnetic mirror systems and their relation to plasma contentment devices.

Magneto-Hydrodynamics (MHD): **[10 lectures]**

Introduction to ideal MHD system; fundamental equations of magneto-hydro dynamic systems; diffusion and mobility of charged particles in plasma; plasma as a fluid and MHD equations; approximations and linearization of MHD from dimensional considerations; single fluid MHD equation.

Waves and Instabilities in Plasma: **[16 lectures]**

Waves in un-magnetized plasma; energy transport; ion-acoustic waves and MHD waves; plasma stability and the use of normal modes to analyzed stability; interaction between plasma particles; perturbation at two fluid interface; Raleigh Taylor instability; Kelvin Helmholtz instability; Jeans instability.

Kinetic Theory: **[12 lectures]**

Need for kinetic theory and MHD as approximation of kinetic theory; phase space for many particle motion; velocity and space distribution function; electron-ion plasma oscillation frequency; derivation of Landau damping and Vlasov equations for fluid dynamics.

Reading List

1. Introduction to Plasma Physics and Controlled Fusion: F. Chen and F. Chen.
2. Introduction to Plasma Physics: R. Goldston and P. Rutherford.

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After threadbare discussion about every part of the syllabus in the BOS meeting and specially taking into consideration the suggestion and advice of the external members, we have incorporated the change suggested by them in the final draft syllabus submitted to the University. Moreover, on the basis of the suggestion put forward in the BOS meeting, we would like to put the following points in our draft syllabus as a note for possible future action.

- The department can change in later time up to twenty percent of the contents of syllabus of any paper without violating the basic structure.
- New papers can be added by the department, subject to the approval of the Vice Chancellor, without changing the basic structure of the system.
- In some cases specially in the case of SPL and OPE papers in the PG section and DSE papers of UG course, the credit distribution across L, T and P will be changed without changing the total credit for each paper. This will be particularly effected when the department can afford to provide the necessary infrastructure and equipments for the laboratory.
- The experimental list of any paper may be modified by the department, adding new experiments or deleting some already existing ones.