SACRED HEART COLLEGE (AUTONOMOUS), THEVARA
KOCHI, KERALA, 682013

CURRICULUM AND SYLLABI

CHOICE BASED COURSE CREDIT AND SEMESTER SYSTEM

(CBCSS)

M.Phil. Physics PROGRAMME

INTRODUCED FROM 2015 ADMISSION ONWARDS

BOARD OF STUDIES IN PHYSICS

Sacred Heart College, Thevara, Kochi, Kerala

Report of the Board of Studies

Board of Studies meeting was held on November 01, 2014. A total of 14 members were present including all the nominated members from outside.

Prof. George Philip – *HoD*

Dr. Georgekutty Joseph (*Chairman*, BOS)

Prof. (Dr.) N.V. Unnikrishnan (M.G.University, VC Nominee)

Dr. Joechan Joseph (S.A.College, Edathua)

Dr. Pramod Gopinath (IIST, Trivandrum)

Dr. Ison V Vanchipurackal (St.Thomas College, Pala)

Mr. Kuruvilla George (Industrialist, Ernakulam)

Dr. Siby Mathew

Prof. George V.M

Prof. Alex Shinu Scaria

Dr. Roby Cherian

Dr. Jimmy Sebastian

Dr. Sumod.S.G. (*Secretary*, BOS)

Approved the panel for the Examiners for both UG and PG programmes.

Modified the components in the distribution of marks in Internal Continuous evaluation scheme. The two conventional assignments in the present scenario will be modified with one assignment as Open book/Open library Tests. The other one will still remain as such, but will be focused only on solving physics problems, which will be different for different students.

Modified and approved the question paper pattern for PG in such a way as to help the students to win many competitive examinations such as GATE/NET/JEST etc.

Proposal for a new Mphil course was discussed and approved. The syllabus, scheme and other activities such as making MoUs with the other research labs/universities etc. were discussed in detail. A committee was selected from the Board of Studies (BOS) with Dr. Georgekutty Joseph as the Chairman.

Separate committees were formed for both UG and PG programmes for making necessary modifications in the existing scheme/syllabus, if any with Prof. George Philip and Prof. (Dr.) N.V.Unnikrishnan as the respective chairpersons.

'Skill-development' was introduced in the curriculum as a separate component for both UG and PG programmes. This will promote the students to come out with originality of thoughts/creativity and ability of making independent decisions. As an initial step, forthe UG students, the revival of 'Home Tech' programme along with introducing hobbies like amateur radio was suggested.

Decided to promote the students to use tools in the advanced technology in the field of science, such as introducing new software packages such as Origin, Matlab etc during lab activities.

Identified conveners to conduct the International Seminar, Refresher course (Academy of Science) and Space Science Exhibition (ISRO) at our institution.

Decided to promote UG level students to design new instruments, use Virtual labs, Phenix etc.

After making the necessary decisions, a common mail will be circulated among the members of BOS.

The meeting came to an end at 01:15 pm.

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1. PROGRAMME OVERVIEW

2. COURSE STRUCTURE

3. GRADING AND EVALUATION

4. DETAILED SYLLABUS

1. PROGRAMME OVERVIEW

1. Scope

The Master of Philosophy (M.Phil), in Physics is a semester based one year programme designed for academicians and researchers to provide theoretical and practical research exposure in Physics. The programme empowers the researchers with domain specific capabilities and methodological competencies.

Applicable to all regular (self-financing) M.Phil Programmes conducted by the Sacred Heart College (Autonomous) with effect from 2015-16 admissions.

2. Course Duration

The duration of the course is one year spread across two semesters.

3. Eligibility criteria

A pass in M.Sc Physics (Pure, Applied, Materials Science, Theoretical Physics, New & Renewable energy, Non-conventional Energy Physics) with not less than 55% mark. The degree shall be from this University or shall have been recognized by this University.

4. Admission procedure

Admission will be on the basis of the marks in the qualifying examination, written test and interview in a ratio of 50 : 40 : 10.

2. COURSE STRUCTURE

I. Course Structure

Sl. No.	Course code	Semester	Course title	Contact hours per week	Credits
1.	15 MPPHY T1	I	Research Methodology (Common course)	6	4
2.	15 MPPHY T2	I	General Physics I (Common course)	6	4
3.	15 MPPHY T3	I	General Physics II (Common course)	6	4
4.	15 MPPHY T4	II	Elective course	6	4
5.	15 MPPHY PD	II	Project	30	20
6.	15 MPPHY PV	II	Viva on Project	-	4
				Total Credit	40

Elective courses: Options (to be framed/decided by the project guide)

Sl. No.	Course code	Semester	Course title	Contact hours per week	Credits
1.	15 MPPHY T4	II	Quantum Field Theory	6	4
2.	15 MPPHY T4	II	Plasma Physics	6	4
3.	15 MPPHY T4	II	Quantum heterostructures	6	4
4.	15 MPPHY T4	II	Atmospheric and Space Science	6	4

II. Course Code

The first two alphabets represent the college i.e., Sacred Heart College, third alphabet, the

program M.Phil and the fourth one for Physics. The following digit and the alphabet represent the semester. The subsequent alphabet and the last digit represent the course.

3. GRADING AND EVALUATION

Examinations

The evaluation of each course shall contain two parts such as Internal or In-Semester Assessment. (IA) and External or End-Semester Assessment (EA). The ratio between internal and external examinations shall be 1:3. The Internal and External examinations shall be evaluated using Direct Grading system based on 5-point scale.

Internal or In-Semester Assessment (IA)

Internal evaluation is to be done by continuous assessments of the following components. The components of the internal evaluation for theory and practicals and their weights are as in the Table. The internal assessment should be fair and transparent. The evaluation of the components should be published and acknowledged by students. All documents of internal assessments are to be kept in the institution for 2 years and shall be made available for verification by the university. The responsibility of evaluating the internal assessment is vested on the teacher(s) who teach the course. The two test papers should be in the same model as the end semester examination question paper, the model of which is discussed below. The duration and the number of questions in the paper may be adjusted judiciously by the college for the sake of convenience.

THEORY (Semester I)	
Component	Marks
Attendance	5
Assignments.	5
Seminar	5
Test-1	5
Test-II	5
Total internal Marks for one theory paper =25	

Project	Marks
Relevance /Quality of project under study	30
Literature survey	60
Experimental/Theoretical / Data validation/ Modeling	60
Result and Dissertation layout	60
Presentation of the project	90
Total Marks	300

Distribution of marks and components of theory and project

Attendance		Assignments		Seminar	
% of Attendance	Marks	Components	Marks	Components	Marks
≥90%	5	Punctuality	0.5	Innovation of Topic	0.5
≥85% and <90%	4	Review	1	Review/ Reference	0.5
≥ 80% and <85%	3	Content	2	Content	1.5
≥75% and <80%	2	Conclusion	1	Presentation	1.5
<75%	1	References	0.5	Conclusion	1

Both project evaluation and viva voce examination are to be conducted in batches of students formed for the practical examinations.A total of 100 marks is there for project viva of which 50 marks is by internal evaluation and 50 marks by external evaluation.

Question Paper Pattern for Theory Courses.

All the theory question papers are of three hour duration. All question papers will have three parts with total marks of 75.

Part A: (very short answer questions) Questions from this part are very short answer type. Six questions have to be answered from among ten questions. Each question will have mark two and the Part A will have a total mark of 12. A minimum of two questions must be asked from each unit of the course.

Part B: (short answer questions) Part B is fully dedicated to solving problems or short essays from the course concerned. Three questions out of six given have to be answered. Each question has mark five making the Part B to have total mark 15. A minimum of one problem from each unit is required.

Part C: Part C will have four questions (essay questions). Four questions should be answered

from eight long answer type questions. Two questions of equal standard must be asked from each module. Each question will have a mark of twelve making the total marks 48.

Reappearance/Improvement: For reappearance / improvement as per university rules, students can appear along with the next regular batch of students of their particular semester. A maximum of two chances will be given for each failed paper. Only those Papers in which candidate have failed need be repeated. Chances of reappearance will be available only during the starting semester in which admission/ readmission is given to the candidate.

Proposed Changes for M.Phil Physics 2015 batch

Sl. No	Existing	Proposed for M.Phil Physics
1		The syllabus for the course Research Methodology is changed to that of the Ph.D. course work for Science, Applied Science and Engineering of the Mahatma Gandhi University
2	Credit to paper I,paper II,paper III - 6 each Credit for elective-7 Credit for Project viva- 5 Total credit-50	Credit for all papers including elective-4 each Credit for Project viva-4 Total credit-40 Only three papers in semester I and one elective based on project in semester II
3	Marks for project viva – not mentioned	Total-100 marks.
4	Marks for Project-not mentioned	300 marks (Internal 150 and external 150)
5	Minimum for pass- Not mentioned	Separate minimum for coursework- internal and external-40% Aggregate Minimum-50%
6	Pattern of question paper: Very Short Answers- 6/10 Short answer questions- 4/6 Long Answer type- 4/8 with internal option Total weight-30	Pattern of question paper Very Short Answers- 6/10 Short answer questions- 3/6 Long Answer type- 4/8 Total marks-75
7	Internal and external Marks not mentioned	Internal-external marks 25 and 75 for theory papers

4. DETAILED SYLLABUS

COMMON COURSE (1)

15MPPHYT1 : RESEARCH METHODOLOGY

(CREDITS 4) **108 hrs**

MODULE 1 **30 hrs**

Science and Research:

Definition – History – Evolution of Scientific Inquiry – Verification versus falsification – Objectivity : Facts, theory and concepts – Philosophy of Science and Technology, Epistemology of sciences – Construction of scientific facts.

Introduction to Research Methodology

- Meaning and importance of Research – Types of Research – Selection and formulation of Research Problem
- Research Design – Need – Features – Inductive, Deductive and Development of models
- Developing a Research Plan – Exploration, Description, Diagnosis, Experimentation, Determining Experimental and Sample Designs.
- Analysis of Literature Review – Primary and Secondary Sources, Web sources –critical Literature Review
- Hypothesis – Different Types – Significance – Development of Working Hypothesis
- Research Methods: Scientific method vs Arbitrary Method, Logical Scientific Methods: Deductive, Inductive, Deductive-Inductive, pattern of Deductive – Inductive logical process – Different types of inductive logical methods.

MODULE 2 **30 hrs**

Data Collection and Analysis

- Sources of Data – Primary, Secondary and Teritary – Types of Data – Categorical, nominal & Ordinal.
- Methods of Collecting Data: Observation, field investigations, Direct studies – Reports, Records or Experimental observations.
- Sampling methods – Data Processing and Analysis strategies- Graphical representation – Descriptive Analysis – Inferential Analysis- Correlation analysis – Least square method - Data Analysis using statistical package – Hypothesis – testing – Generalization and Interpretation – Modeling.

MODULE 3 **30 hrs**

Scientific Writing

- Structure and components of Scientific Reports – types of Report – Technical Reports and Thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports - Illustrations and tables – Bibliography, Referencing and foot notes – Oral presentation – Planning – Preparation and practice – Making presentation – Use of visual aids – Importance of Effective Communication.
- Conventions and strategies of Authentication – Citation Style - sheet
- Preparing Research papers for journals, Seminars and Conferences – Design of paper using TEMPLATE, Calculations of Impact factor of a journal, citation Index, ISBN & ISSN.
- Preparation of Project Proposal - Title, Abstract, Introduction – Rationale, Objectives, Methodology – Time frame and work plan – Budget and Justification - References

MODULE 4 **18 hrs**

Application of Results and Ethics

Environmental Impacts - Ethical Issues – Ethical Committees – Commercialization – copy right – royalty – Intellectual Property rights and patent law – Track Related aspects of intellectual

property Rights – Reproduction of published material – Plagiarism – Citation and Acknowledgement – Reproducibility and accountability.

Application of Computer in Research

- MS office and its application in Research – MS Word, MS Power point and MS Excel
- Basic principles of Statistical Computation using SPSS
- Use of Internet in Research – Websites, searches Engines, E-journal and E-Library – INFLIBNET.

References: Science

1. Santhosh Gupta , Research Methodology And Statistical Techniques, Deep And Deep Publications, New Delhi
2. Kothari, C.R.(2008). Research Methodology: Methods and Techniques. Second Edition. New Age International Publishers, New Delhi.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
4. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270 p.
5. Day RA (1992) How to write and publish a scientific paper. Cambridge University press. London
6. Gupta S.P. (2008). Statistical Methods. 37th ed. (Rev)Sultan Chand and Sons. New Delhi. 1470 p.
7. Wadehra, B.L.2000. Law relating to patents, trade marks, copyright designs and geographical indications. Universal Law Publishing.
8. Sinha p.K.(1992). Computer Fundamentals, BPB Publications, New Delhi.
9. SPSS –operating manual and handbook

15MPPHYT2 : GENERAL PHYSICS I

(Credits: 6) **108 Hrs**

Module I (Mathematical Physics) 27 Hrs

Dimensional analysis - Vector algebra: Scalar and Vector products, Triple products - vector calculus: Gauss's, Stokes and Green's theorem (no proof) - orthogonal curvilinear coordinates: gradient, divergence, curl and Laplacian in Cartesian, spherical polar and cylindrical co- ordinate systems, Line, Surface and Volume elements - Linear algebra, matrices:hermitian,unitary&orthogonal matrices Cayley- Hamilton Theorem, Eigen values and Eigen vectors - Linear ordinary differential equations of first & second order – Differential equations with variable coefficients:Frobenius method.Special functions (Hermite, Bessel, Laguerre and Legendre functions) - Fourier series, Fourier and Laplace Transforms - Complex algebra -De Moivres formula, Elements of complex analysis, analytic functions, Cauchy-Riemann conditions- Cauchy's integral theorem, Cauchy's integral formula Taylor & Laurent series, poles, ,residues, Calculus of residues-singularities, residue theorem, evaluation of definite integrals, Jordan's lemma, Singular points, evaluation of integrals - one dimensional Dirac delta function, properties and representations.

Text Books

1. Jon Mathews and R.L. Walker, Mathematical Methods of Physics.

2. George Arfken, Mathematical Methods for Physicists, Fourth (Prism Indian) Edition

Module II (Classical Mechanics) 27 Hrs

Newton's laws - Dynamical systems –Equations of canonical transformation-generators Poisson brackets and canonical transformations, Infinitesimal canonical transformation : Non-inertial frames and pseudo forces - Hamilton-Jacobi theory - Variational principle - Generalized coordinates - Lagrangian and Hamiltonian formalism and equations of motion - Conservation laws and cyclic coordinates - Periodic motion: Small oscillations, formulation of the problem , eigenvalue equation &the principal axis transformation, ,-frequencies of free vibrations&free vibration of linear triatomic molecules -normal coordinates - Special theory of relativity:Basic postulates- Lorentz transformations, relativistic kinematics: four vectors - mass–energy equivalence.

Text Books

1. H. Goldstein, C. Poole and J. Safko , Classical Mechanics

2. N. C. Rana and P. S. Joag, Classical Mechanics

3. Y.K.LIM, LIM SERIES: Problems and solutions on classical mechanics (For Problems)

Module III (Electrodynamics) 27 Hrs

Electrostatics: Gauss's law and its applications, Laplace and Poisson equations, boundary value problems - Magnetostatics: Biot-Savart law, Ampere's theorem - Electromagnetic induction -. Maxwell's equations in free space and linear isotropic media - boundary conditions on the fields at interfaces – Electromagnetic waves in free space, dielectrics and conductors, linear and circular polarization, reflection and refraction at a dielectric interface, polarization by reflection and total internal reflection - Radiation from moving charges and dipoles : retarded potentials, Vector and scalar potentials – gauge transformations: Lorentz gauge, Coulomb Gauge - Poynting's theorem and conservation of energy and momentum, complex Poynting vector.

Text Books:

1. J. D. Jackson, Electrodynamics

2. David J Griffiths, Introduction to Electrodynamics

Module IV (Quantum Mechanics) 27 Hrs

Wave-particle duality - Schrödinger equation (time-dependent and time-independent) - Eigenvalue problems: particle in a box (one dimensional), harmonic oscillator, Tunneling through a barrier - Wave-function in coordinate and momentum representations - Commutators and Heisenberg uncertainty principle - Dirac notation for state vectors - Motion in a central potential: orbital angular momentum, angular momentum algebra, spin- Stern-Gerlach experiment- Time independent perturbation theory and applications- Variational method- Identical particles, Pauli Exclusion Principle, spin statistics connection- Spin-orbit coupling, fine structure- Relativistic quantum mechanics: Klein-Gordon and Dirac equations.

Text Books

1. G. Aruldhas, Quantum Mechanics

2. D.J.Griffith, Introduction to Quantum Mechanics

3. V.K. Thankappan, Quantum Mechanics

4. Nouredine Zettili, Quantum mechanics concepts and applications

5. Y.K.LIM, LIM SERIES: Problems and solutions on quantum mechanics (For Problems)

15MPPHYT3 **: GENERAL PHYSICS II**

(Credits: 6) 108 Hrs

Module I (Thermodynamic and Statistical Physics) 27 Hrs

Laws of thermodynamics and their consequences - Thermodynamic potentials: Maxwell relations - chemical potential - Phase space, micro- and macro-states - Micro canonical, canonical and grand-canonical ensembles and partition functions - First and Second Order Phase Transitions, phase equilibrium - Bose-Einstein condensation - Introduction to non-equilibrium processes - Free energy and its connection with thermodynamic quantities - Classical and quantum statistics - Ideal Bose and Fermi gases - Blackbody radiation and Planck's distribution law.

Text Books

1.R. K. Pathria, Statistical Mechanics

2. K. Huang, Statistical Mechanics

3. Y.K.LIM, LIM SERIES Problems and solutions on statistical mechanics

Module II (Atomic & Molecular Physics) 27 Hrs

Quantum states of an electron in an atom, Electron spin - LS & JJ couplings - Zeeman-Paschen-Bach & Stark effects - Nuclear magnetic resonance, chemical shift - - Electronic:Frank-Condon principle, Born-Oppenheimer approximation, rotational, vibrational and Raman spectra of diatomic molecules, selection rules - Lasers: spontaneous and stimulated emission, Einstein’s A &B coefficients, Optical pumping, population inversion, rate equation.

Text Books

1. H. E. White, Introduction to Atomic Spectra

2. C. N. Banwell and Elaine M. McCash, Fundamentals of Molecular Spectroscopy

3. Rajkumar, Atomic and molecular spectra:laser

4. Y.K.LIM, LIM SERIES Problems and solutions on atomic, nuclear and particle physics

Module III (**Condensed Matter Physics)** **27 Hrs**

Bravais lattices, packing fraction, Reciprocal lattice - Diffraction and the structure factor - Bonding of solids - Elastic properties, phonons - lattice specific heat - Free electron theory and electronic specific heat - Response and relaxation phenomena - Hall effect and thermoelectric power - Electron motion in a periodic potential - band theory of solids: metals, insulators and semiconductors - Superconductivity: type-I and type-II superconductors, Josephson junctions, Super fluidity - Defects and dislocations.

Text Books

1 .A. J. Dekker, Solid State Physics

2. C. Kittel, Introduction to Solid State Physics

3. A. R. A. Levy, Introduction to solids

4. L. V. Azaroff, Introduction to X ray Crystallography

5. Y.K.LIM, LIM SERIES Problems and solutions on solid state physics

Module IV (Nuclear and Particle Physics) **27 hrs**

Basic nuclear properties: size, shape and charge distribution, spin and parity - Binding energy, semi empirical mass formula, liquid drop model - Nature of the nuclear force: charge-independence and charge-symmetry of nuclear forces - Deuteron problem - Evidence of shell structure, single-particle shell model, its validity and limitations, Rotational spectra - Nuclear reactions, reaction mechanism, compound nuclei and direct reactions - Classification of fundamental forces - Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.), Gellmann-Nishijima formula - Quark model: baryons and mesons - C, P, and T invariance.

Text Books:

1. Harald A Enge, Introduction to Nuclear Physics

2. Kenneth S Krane, Introductory Nuclear Physics

3. David Griffiths, Introduction to Elementary Particles

4. Y.K.LIM, LIM SERIES Problems and solutions on atomic, nuclear and particle physics

Elective Course 1

15MPPHYT4EL1: QUANTUM FIELD THEORY

(Credits: 4) **126 Hrs**

Module I **40 Hrs**

Elements of Classical Field theory: Lagrangian and Hamiltonian densities, quantization of KG and Dirac and electromagnetic fields, propagators for KG, Dirac and vector (photons). Perturbation theory: Wick's theorem and Wick expansion, Feynman diagrams, cross sections and S matrix. Feynman rules for scalars, spinors and gauge fields (Abelian).

Module II **20 Hrs**

Elementary processes in QED: electron positron annihilation, Compton scattering, Bhabha scattering, crossing symmetry etc.

Module III **38 Hrs**

Radiative corrections for scalar theory: loop corrections, regularization and renormalization, dimensional regularization. Elementary ideas of the systematics of renormalization. Functional method techniques: Scalar field theory quantization (with, if time permits, some discussion of critical phenomena in this approach).

Module IV **28 Hrs**

Non-interacting electrons: Tight binding models, the many body ground state, quasi-particle and quasi-hole excitations. Partially filled bands and Fermi surface kinematics.

References:

1. M. E. Peskin and D. V. Schroyder, Quantum Field Theory, Sarat Book House, 2005.

Elective Course 2

15MPPHYT4EL2: PLASMA PHYSICS

(Credits: 4) **126 Hrs**

Module I **32 Hrs**

Plasma state, characterisation, occurrence of plasma in nature, definition, concept of temperature, debye shielding, plasma parameters, criteria for plasma, applications of plasma physics (basis ideas) single particle motions: uniform E and B fields - Non uniform B and E fields -Summary of guiding centre drifts - magnetic mirrors, time - varying B and E fields, adiabatic invariants.

Module II **28 Hrs**

Plasma as fluids, the equation of motion, fluid drifts perpendicular to B, fluid drifts parallel to B, the plasma approximation, equilibrium and stability, hydromagnetic equilibrium, concept of diffusion of magnetic field into plasma, classification of instabilities, two stream instability, the gravitational instability, resistive drift waves, the weibel instability.

Module III **28 Hrs**

Representation of waves, group velocity, plasma oscillations, electron plasma waves, sound waves, ion waves, validity of plasma approximation, comparison of ion and electron waves, electromagnetic waves with $B_0=0$, experimental applications, electromagnetic waves perpendicular and parallel to B_0, experimental consequences, hydromagnetic waves, Alfven waves, magnetosonic waves, summary of elementary plasma waves, CMA diagram.

Module IV **38 Hrs**

Kinetic theory, meaning of f(v) equations by kinetic theory, derivations of the fluid equation, plasma Oscillations and Landau damping, meaning of Landau damping, physical derivation of Landau Damping, plasma diagnostics, eelectrical methods, Langmuir profits spectroscopic methods, line spectrum of a plasma, low density plasma, high density plasma ionization state of a plasma, particle methods, beam of charged particle to measure electric field in a plasma – measurement of the density of natural particles and charged particles.

References:

1. F. F. Chen, Introduction to plasma physics and controlled fusion, vol 1, Plenum press, 1983.

Elective Course 3

15MPPHYT4EL3: QUANTUM HETEROSTRUCTURES

(Credits: 4) **126 Hrs**

Module I **36 Hrs**

Electrons in quantum structures, quantum wells, quantum wires, quantum dots, coupling between quantum wells, superlattices, excitons quantum structures, properties of quantum structures, energy spectra of semiconductor materials, lattice matched and pseudomorphic heterostructures, single heterojunction devices, modulation-doped quantum structures.

Module II **36 Hrs**

Electron scattering in quantum structures, electron scattering in two-dimensional electron systems, screening of a two-dimensional electron gas, scattering by remote ionized impurities, scattering by interface roughness, electron-phonon interaction, interaction with acoustic and optic phonons, interaction in wells and wires.

Module III **36 Hrs**

Parallel transport in quantum structures, linear electron transport, high field electron transport, hot electrons in quantum structures, perpendicular transport in quantum structures, perpendicular transport in quantum structures, double-barrier resonant-tunneling structures, super lattices and ballistic injection devices, single electron transfer and Coulomb blockade.

Module IV **18 Hrs**

Electronic devices based on quantum heterostructures, FET, velocity modulation and quantum interference transistors, bipolar heterostructure transistors, hot electron transistors.

References:

1. V.V. Mitin, V.A. Kochelap, M.A. Stroscio, Quantum heterostrucures, Cambride University press (1999).

2. G.W. Hanson, Fundamentals of nanoelectronics, Pearson (2010).

Elective Course 4

15MPPHYT4EL4: ATMOSPHERIC AND SPACE SCIENCES

(Credits: 4) **126 Hrs**

Module I **18 Hrs**

Basic structure of Atmosphere-Hydrostatic Equilibrium-Scale Height-Geo potential Height-Thermodynamic considerations-Elementary Chemical Kinetics-Composition and Chemistry of Lower, Middle and Upper Atmosphere-Thermal Balance in Thermosphere

Module II **36 Hrs**

Solar Radiation at the Top of the Atmosphere-Attenuation of Solar radiation in the Atmosphere-Radiative Transfer-Thermal Effects of Radiation- Photochemical Effects of Radiation.

Equation of Motion of Neutral Atmosphere-Thermal Wind Equation-Elements of Planetary waves-Internal Gravity waves and Atmospheric Tides-Fundamental Description of Atmospheric dynamics and Effects of Dynamics on Chemical Species

Module III **36 Hrs**

Introduction of Earth's Ionosphere-Chapmann's Theory of Photoionization-Continuity equation and photochemical equilibrium-Loss processes-α and β Chapman layers-Chemistry of E and F1 regions-D region chemistry-F region splitting-Vertical Transport-Ambipolar diffusion and F2 peak-Topside ionosphere

Module IV **36 Hrs**

Properties of magnetoplasma-Gyrofrequency-Plasma frequency-Debye length and Frozen in field-Basic fluid dquation-Steady state plasma motions due to applied forces-Electrical conductivity of the ionosphere-Generation of electric field and electric field mapping-Ionosphere dynamo-Ionospheric irregularities-Equatorial Spread F and Equatorial Electrojet-Equatorial Ionization Anomaly, Sporadic E.

Space weather, Geomagnetic storms, solar flares, coronal mass ejections, Effect of Magnetic disturbance on Ionosphere and Thermosphere.

References:

1. Wallance, John and Hobbs, Peter, Atmospheric Sciences- An Introductory Survery, Academic Press, 2006
2. Rees M.H, Physics and Chemistry of the Upper Atmosphere-Cambridge University Press, 1989
3. Andrews, D.G., Middle Atmosphere Dynamics (Int.Geophysics Series V40, Holton Jr, USA, Academic Press, 1987
4. Hargreaves, J.K., The Solar-Terrestrial Environment: An Introduction to Geospace-The Science of the Terrestrial Upper Atmosphere, Ionosphere, and Magnetosphere, Cambridge University Press, 1992
5. Rishbeth, H and OK Garriott, Introduction to Ionospheric Physics, Academic Press, New York, 1969
6. Kelley M.C, Earths Ionosphere, ,Academic Press, 1989.

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