Integrated MS(R)-PhD Program in Physics (Space Physics)

About course:

The Integrated MS(R)-PhD Program in Physics (Space Physics) combines a Master of Science (MS) and a Doctor of Philosophy (PhD) degree into a single, continuous program, allowing students to earn both degrees. These programs are particularly appealing to students interested in research and offer a pathway to a PhD while providing the option to exit with an MS degree. It offers students a unique opportunity to explore the fundamental processes governing space, planetary, and astrophysical environments. This interdisciplinary program combines advanced knowledge of physics, mathematics, space science and geomagnetism, preparing students for careers in research, space technology, and related industries. With growing global interest in space exploration and satellite technology, graduates of this program are well-positioned for opportunities in both academic and applied space sectors. Indian Institute of Geomagnetism (IIG) offering this course since 2026. The degree will be awarded from Jawaharlal Nehru University, New Delhi.

About Institute:

Indian Institute of Geomagnetism is a premier research institute of national and international importance, actively engaged in basic and applied research in Space Science and Geomagnetism that covers several phenomena from surface of the Sun to the interior of the Earth. It started out as a successor to the Colaba Magnetic Observatory and its legacy dates back to 1841. In 1971, IIG became an autonomous organization and is currently functioning under the Department of Science & Technology, Govt. of India. It operates four regional labs namely, Dr. K.S. Krishnan Geomagnetic Research Laboratory (KSKGRL), Prayagraj; Equatorial Geophysical Research Laboratory (EGRL), Tirunelveli; North-East Geophysical Research Laboratory (NEGRL) and Colaba Geomagnetic Research Laboratory (CGRL), Mumbai with fourteen magnetic observatories nationwide to monitor the geomagnetic field. It holds several experiments to monitor micro and macro level processes near Earth that has direct implications to our space assets. The vision of IIG is to promote, guide, and conduct research in all branches of Geomagnetism and allied subjects. It is a premier national-level institute that brings together experienced researchers and scientists to offer a high-quality Integrated MS(R)-PhD Program in Physics (Space Physics) to start with.

Scope of the Integrated MS(R)-PhD Program in Physics (Space Physics)

The MS(R)-PhD program in Physics (Space Physics) equips students with a deep understanding of space environments, plasma physics, atmospheric sciences and related disciplines. The program offers vast opportunities for both academic and industry careers, including, (i) Research and Development, (ii) Space Industry and Technology, (iii) Further Academic Pursuits like PhD in Space Science or related fields, both in India and abroad, (iv) Emerging Private Space Sector opportunity as skilled professionals, etc.

Key features of program

- Exclusive, dedicated Research-Focused Integrated MS(R)-PhD Program with exit option at MS level with emphasis on Computational and Programming Training
- Program integrates basic and advanced courses with hands-on research experience.

- Core lectures by leading experts in the field of Space Science and technology. In addition, Guest lectures through regular seminar series and invited talks from other renowned institutions like PRL, IIA, IISc, IITs, etc.

Eligibility and Admission Process

Candidates must hold a BS degree in Physics (Regular, 3-year or 4-year) with a minimum of 60% marks or an equivalent CGPA with Mathematics as one of the subjects studied during their BS program. Students who are in the final year of their Bachelor's degree and awaiting results are also eligible to apply. A relaxation of 5% marks or equivalent CGPA will be granted to candidates belonging to SC/ST/OBC (Non-Creamy Layer)/PWBD/Economically Weaker Sections (EWS), upon submission of a valid certificate. Reservation policy of Government of India will be followed. Candidate holding either a 4-year Bachelor of Science (BS) degree or a 3-year BS degree, in Physics are typically eligible to apply for Integrated MS(R)-PhD Program. In addition, candidates are required to submit their scorecard from CUET, JAM, or JEST national-level examinations. There are two entry levels as shown below.

Duration of Program:

Entry Level	Eligibility	Duration [MS+PhD#]	Exit Option
Entry Level 1	BS (3-year degree)	2+5	Exit after 1-year lead to MS(R) Diploma in Physics (Space Physics) [UGC Level 6] Exit after 2-year lead to MS(R) degree in Physics (Space Physics) [UGC Level 6.5]
Entry Level 2	BS (4-year degree)	1+5	Exit after 1-year lead to MS(R) degree in Physics (Space Physics) [UGC Level 6.5]

 # Only students with a minimum of 60% or equivalent CGPA marks at MS(R) degree will be admitted to PhD Program. A relaxation of 5% marks or equivalent CGPA will be granted to candidates belonging to SC/ST/OBC (Non-Creamy Layer)/PWBD/Economically Weaker Sections (EWS).

Maximum Age:
25 years as on 1st July, year of admission.

Selection Criteria
The selection process will be carried out in three stages:
1. Shortlisting based on the academic qualifications specified above.
2. Screening of candidates holding a valid CUET, JAM, or JEST scorecard.
3. Personal interview.

How to apply:
The Integrated MS(R)-PhD Program will be announced annually, typically around February to March. Interested candidates can apply by filling up the application form and paying a non-refundable application fee as given below. Applicants are required to upload scanned copies of

all relevant documents during the application process. Upon successful submission, an email confirmation will be sent to the candidate. The merit list of selected candidates will be published on IIG website by July. Selected candidates will receive an official offer letter via email. To secure admission, candidates must accept the offer and complete the fee payment (as applicable) before the commencement of the course within the time provided.

General Category	Application Fee Rs. 2000/-
SC/ST/OBC (Non-Creamy Layer)/PWBD/Economically Weaker Sections (EWS)	Application Fee Rs. 1500/-

Admission Schedule (tentative)	
Announcement of Program	February-March
Application	March-April
Interview	May-June
Final Selection	July
Fees Payment	July
Start of Course	2nd week of August

Cancellation and Refund Policy:
If a cancellation and refund request is submitted within 30 days of the payment, a 100% refund will be processed. No refund requests will be entertained after the commencement of the program. To request a cancellation, students must send an email to iig.msphd@iigm.res.in.

Total seats: 20 (Twenty)

Course location: Indian Institute of Geomagnetism, KSKGRL, Prayagraj, Uttar Pradesh

More Details: https://iigm.res.in/admissions/

Contact: +91-22-27484164

Fee Structure:

Integrated MS(R)-PhD Program

Entry Level 1: Total course fee is 125000/-	Tuition fees	Semester I	Semester II	Semester III	Semester IV
		30000	30000	30000	30000
	Admission fees (one time, non-refundable)	5000			

Entry Level 2: Total course fee is 125000/-	Tuition fees	Semester I	Semester II	Semester III	Semester IV
		60000	60000	NA	NA
	Admission fees (one time, non-refundable)	5000			

For students admitted to subsequent PhD program the Fees and Fellowship will be as per IIG norms.

Hostel and Mess charges

Limited hostel sharing accommodations are available on payment basis during MS course

Hostel charges	120000/- (Entire course duration i.e., 4 semesters)
Mess charges	As applicable

 # For each semester fee need to be deposited well before commencement of respective semester.

During PhD course students will be provided hostel accommodation (if available) as per IIG norms.

Contact us

More about Indian Institute of Geomagnetism is available at https://www.iigm.res.in. For any queries write to iig.msphd@iigm.res.in. Phone: +91-22-27484164

Address:

Indian Institute of Geomagnetism, Autonomous Institute under Department of Science and Technology, Plot 5 Sector 18, New Panvel (w), 410206.

How to reach: https://maps.app.goo.gl/cWUc2waQ51Kt8nuFA

Academic Curriculum

Semester wise credits (Entry Level 1):Total 80 credit points

Semester I	Semester II	Semester III	Semester IV
20	20	20	20

Semester I (6 papers)

Subject code	Subject title	L	T	P	C	Semester I
SP001	Mathematical Methods	3	0	0	3	
SP002	Electrodynamics	3	0	0	3	
SP003	Geomagnetism	3	0	0	3	
SP004	Plasma Physics	3	0	0	3	
SP005	Computational Physics	3	0	1	3	
SP006	Magnetospheric Physics	3	0	0	3	
SP007	Data Handling and Analysis (Lab Session)	0	0	6	2	
	Total	18	0	7	20	

Semester II (5 papers, seminar, Viva)

Subject code	Subject title	L	T	P	C	Semester II
SP008	Elective Environmental Magnetism Applied Geophysics	3	0	0	3	
SP009	Atmospheric Physics	3	0	0	3	
SP010	Solar Physics	3	0	0	3	
SP011	Ionospheric Physics	3	0	0	3	
SP012	Space Weather	3	0	0	3	
SP013	Magnetic observatory and Instrumentation	0	0	6	2	
SP014	Computer Programming	0	0	3	1	
SP015	Seminar +Comprehensive Viva	0	0	0	2	
	Total	15	0	12	20	

Semester III (thesis, seminar)

Subject code	Subject title	L	T	P	C	Semester III
SP016	Seminar	0	0	0	2	
SP017	Thesis Phase I	0	0	0	18	
	Total	0	0	0	20	

Semester IV (thesis, seminar)

Subject code	Subject title	L	T	P	C	Semester IV
SP018	Thesis Phase II	0	0	0	18	
SP019	Thesis Seminar-Viva	0	0	0	2	
	Total	0	0	0	20	

L – Lectures (hours per week), T – Tutorials (hours per week), P – Practicals (hours per week), C – Credits for the Curriculum

<u>Semester wise credits (Entry Level 2):</u>

Total 40 credit points

Semester I	Semester II	Semester III	Semester IV
20	20	NA	NA

<u>Semester I (6 papers)</u>

Subject code	Subject title	L	T	P	C	
SP001	Mathematical Methods	3	0	0	3	Semester I
SP002	Electrodynamics	3	0	0	3	
SP003	Geomagnetism	3	0	0	3	
SP004	Plasma Physics	3	0	0	3	
SP005	Computational Physics	3	0	1	3	
SP006	Magnetospheric Physics	3	0	0	3	
SP007	Data Handling and Analysis (Lab Session)	0	0	6	2	
SP016	Thesis Phase I (start)	0	0	0	0	
	Total	18	0	7	20	

<u>Semester II (thesis, seminar)</u>

Subject code	Subject title	L	T	P	C	Semester II
SP016	Thesis Phase II	0	0	0	18	
SP017	Thesis Seminar-Viva	0	0	0	2	
	Total	0	0	0	20	

L – Lectures (hours per week), T – Tutorials (hours per week), P – Practicals (hours per week), C – Credits for the Curriculum

Syllabus

SEMESTER I

SP001	Mathematical Methods	3credit/45h

Unit 1: Complex Analysis, Complex Variables, Limits, Continuity, Derivatives, Cauchy-Riemann Equations, Analytic functions, Harmonic functions, Elementary functions: Exponential and Trigonometric, Taylor and Laurent series, Residues, Residue theorem, Principal part of the functions, Residues at poles, zeroes and poles of order m, Contour Integrals, Evaluation of improper real integrals, improper integrals involving Sines and Cosines, Definite integrals involving sine and cosine functions.

Unit 2: Matrices and Tensors, Matrices, Eigenvalues and Eigenvectors, orthogonal, unitary and hermitian matrices, Diagonalization of Matrices, Applications to Physics problems. Introduction to Tensor Analysis, Addition and Subtraction of Tensors, summation convention,

Unit 3: Differential Equations and Integral Transforms, General treatment of second order linear differential equations with non-constant coefficients, Power series solutions, Frobenius method, Legendre, Hermite and Laguerre polynomials, Bessel equations, Nonhomogeneous equation – Green's function, Integral transforms: three dimensional fourier transforms and its applications to PDEs (Green function of Poisson's PDE), convolution theorem, Parseval's relation, Laplace transforms, Laplace transform of derivatives, Inverse Laplace transform and Convolution theorem, Laplace's transform for solving differential equations.

Text / Reference Books:

S. D. Joglekar, Mathematical Methods: The Basics, Universities Press 2005

S. D. Joglekar, Mathematical Methods: Advanced Topics, CRC Press 2007

M.L. Boas, Mathematical methods in the Physical Sciences, Wiley India 2006

G. Arfken and H. J. Weber: Mathematical Methods for Physicists, Academic Press

2005

J. Mathews and R.L. Walker, Mathematical Methods of Physics

A.K. Ghatak, I.C. Goyal and S.J. Chua, Mathematical Methods, McMillan

R. V. Churchill and J.W. Brown, Complex variables and applications, V Ed. Mc Graw. Hill

SEMESTER I

SP002	Electrodynamics	3credit/45h

Unit 1: Electrostatic and Magnetostatics, Coulomb's law, electric field, Gauss's law, (Integral and differential form), scalar potential, potential energy of charge in the electrostatic field, Surface distribution of charges and dipoles, Poisson and Laplace equations, Dirichlet and Neumann boundary conditions, multipole expansion of the potential and multipole moments, Electric field at a point due to an electric dipole, Concept of magnetostatics from continuity equation, Biot-Savart law, Ampere's law, magnetic fields of a localized current distribution, magnetic moments, Faraday laws of induction.

Unit 2: Maxwell's equations, The Poynting vector, The Maxwellian stress tensor, Lorentz Transformations, Electromagnetic waves in vacuum, Polarization of plane waves. Electromagnetic waves in matter, frequency dependence of conductivity, frequency dependence of polarizability, frequency dependence of refractive index. Wave guides, boundary conditions, classification of fields in wave guides, phase velocity and group velocity, resonant cavities.

Unit 3: Moving charges in vacuum, gauge transformation, The time dependent Green function, The Lienard- Wiechert potentials, Leinard- Wiechert fields, application to fields-radiation from a charged particle, Antennas, Radiation by multipole moments, Electric dipole radiation, Complete fields of a time dependent electric dipole, Magnetic dipole radiation

Text / Reference Books:

W.Greiner, Classical Electrodynamics (Springer- Verlag, 2000) (WG).

M.A. Heald and J.B. Marion, Classical Electromagnetic Radiation,

3rd edition (Saunders, 1983)

J.D. Jackson, Classical Electrodynamics, 4Th edition, (John Wiley & sons) 2005 (JDJ)

W.K.H. Panofsky and M. Phillips, Classical Electricity and Magnetism, 2nd edition, (

Addison - Wesley) 1962.

D.J. Griffiths, Introduction to Electrodynamics,2nd EdPrentice Hall, India,1989.

J.R. Reitz ,E.J. Milford and R.W. Christy, Foundation of Electromagnetic Theory, 4th

ed., Addison -Wesley, 1993

SEMESTER I

SP003	Geomagnetism	3credit/45h

Unit 1: Fundamentals of geomagnetism, Earth as giant magnet, source of magnetism, Geodynamo, dipole structure, secular variations, derivation of magnetic scalar potential using Poisson’s equation, Gauss coefficient, Magnetic field reversals, small- and large-scale variations in magnetic field, Spherical harmonic analysis of geomagnetic data, IGRF model, global geomagnetic field, planetary magnetic field environments, formation of magnetosphere.

Unit 2: What is magnetic observatory, Magnetic observations, History of magnetic observations national and global perspective, Magnetic observatory network, world data centre. Application of geomagnetic field data in space science and geophysics.

Unit 3: Establishment of magnetic observatory, field survey, data quality and resolution, Magnetic field measurements from ground and space. Principal, Design and Functioning of different magnetic instruments (PPM, ICM, Fluxgate)

Text / Reference Books:

W.H. Campbell, Introduction to Geomagnetic Fields. Cambridge University Press, 1997

G. Rajaram and P.R. Pisharoty, The Earth’s Magnetic Field, Oxford & IBH Publishing Company Pvt. Ltd., New Delhi, 1998

W.D. Parkinson, Introduction to Geomagnetism. Scottish Academic Press, 1983

R.T.Merrill, M. W. McElhinny and P. L. McFadden, The Magnetic Field of the Earth. Academic Press, 1996

J.A. Jacobs, Geomagnetism Volume 4. Academic Press, 1991

J.A. Jacobs, Geomagnetism Volumes 1, 2 and 3. Academic Press, 1987

SEMESTER I

SP004	Plasma Physics	3credit/45h

Unit 1: The fourth state of matter, Saha's equation, comparison of plasmas, laboratory, space, astrophysical, and industrial applications, Density, temperature, Debye length, plasma frequency, and quasi-neutrality, criteria for plasma existence, Introduction to concept of plasma frequency and gyro-frequency, difference between collisional and collisionless plasmas.

Unit 2: Motion of charged particles in uniform electric and magnetic fields, guiding center motion, gyro-frequency, and gyro-radius (Larmor radius), drifts in non-uniform fields, E×B drift, gradient drift, curvature drift, Vlasov equation and distribution functions, Moments of the distribution function (density, velocity, pressure), fluid equations for plasmas (continuity, momentum, and energy equations), applications to space plasmas.

Unit 3: Electrostatic waves in unmagnetized plasma (Langmuir waves, ion acoustic waves), Electromagnetic waves in plasmas, plasma waves in magnetized plasma (Alfven waves, magnetosonic waves), dispersion relations and phase/group velocities.

Text / Reference Books:

Introduction to Plasma Physics and Controlled Fusion – Francis F. Chen

Basic Space Plasma Physics by Baumjohann and Treumann

Fundamentals of Plasma Physics – J.A. Bittencourt

Plasma Physics for Astrophysics– Russell M. Kulsrud

The Earth's Ionosphere: Plasma Physics and Electrodynamics – Michael C. Kelley

Principles of Plasma Physics for Engineers and Scientists – Umran S. Inan & Marek Golkowski

SEMESTER I

SP005	Computational Physics	3credit/45h

Unit 1: Role of computation in modern Physics research, errors in numerical computations (truncation and round-off errors), Root-finding methods (Bisection, Newton-Raphson, Secant method), Numerical differentiation and integration (Trapezoidal, Simpson's rule), Systems of linear equations (Gaussian elimination, LU decomposition)

Unit 2: Ordinary Differential Equations (ODEs): Euler's method, Runge-Kutta methods, Applications-Projectile motion, harmonic oscillator, damped and driven systems, Partial Differential Equations -Finite difference methods, Heat equation, wave equation, Poisson's equation, Eigenvalue problems

Unit 3: Monte Carlo Methods, Random number generation, Monte Carlo integration, applications in statistical Physics, particle transport, and simulation of random processes, basics of Markov Chains and Metropolis algorithm, Introduction to Fourier Techniques and Signal Analysis, discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), signal filtering and spectral analysis, its applications in data processing, test particle simulations

Practical Session

Solving ordinary differential equations (ODEs) using Euler's and Runge-Kutta methods and their comparison.

Development of a computer code to predict charged particle trajectory in a mutually perpendicular EM field with constant electric and magnetic fields.

Text / Reference Books:

Computational Physics by Nicholas J. Giordano and Hisao Nakanishi

Plasma Physics via Computer Simulation by C.K. Birdsall and A.B. Langdon

Computer Space Plasma Physics: Simulation Techniques and Software, edited by:
H. Matsumoto & Y. Omura (Radio Atmospheric Science Center, Kyoto University, japan)

Numerical Recipes: The Art of Scientific Computing by William H. Press et al.

An Introduction to Computational Physics by T.P. Pang

Computational Physics by J.M. Thijssen

A First Course in Computational Physics by Paul L. DeVries & Javier E. Hasbun

Computational Physics: Problem Solving with Python by Rubin H. Landau et al.

SP006	Magnetospheric Physics	3credit/45h

Unit I: Introduction to the Magnetosphere: Formation: Magnetopause and Bow Shock, Pressure balance. Structure and Regions, plasmasphere, radiation belts, magnetotail, cusps. Sources of plasma: ionosphere, solar wind. Overview of planetary magnetospheres

Unit 2: Solar Wind and IMF (Interplanetary Magnetic Field), Parker solar wind model, IMF orientation and its significance, Magnetosonic and Alfvenic waves in solar wind, Shape and dynamics of the bow shock and magnetopause, Reconnection at the dayside magnetopause, Reconnection at nightside, Role in substorms and energy transfer

Unit 3: Magnetospheric Current Systems: Chapman-Ferraro currents, Ring current and its decay, Field-aligned currents (Birkeland currents), Magnetotail currents. Radiation Belts and Particle Dynamics: Van Allen belts: formation, structure, and dynamics, Wave-particle interactions, Geomagnetic storms, geomagnetic activity indices, Observational Techniques and Space Missions like THEMIS, Cluster, MMS, Van Allen Probes. Modeling and Simulation in Magnetospheric Physics, Global MHD models, Test particle simulations, Empirical models (e.g., IGRF, WMM, T96, Tsyganenko models)

Text / Reference Books:

Baumjohann & Treumann – Basic Space Plasma Physics

Kivelson & Russell – Introduction to Space Physics

Schindler – Physics of Space Plasma Activity

Roederer & Zhang – Dynamics of Magnetically Trapped Particles

Koskinen – Physics of Space Storms

SEMESTER I

SP007	Data Handling and Analysis (Lab Sessions)	2 credit/60h

1. International reference ionosphere (IRI) model data analysis and interpretations
2. Ionospheric data from satellites (CHAMP, SWARM, GOLD etc.) and its analysis
3. Solar irradiance and Sunspot data analysis: Extracting and inferencing solar cycle variability from sunspot number (SSN) and F10.7 solar flux data.
4. Data analysis of space whether related datasets (DST, SYM-H, AE, AL, interplanetary data etc.)
5. Data generation through IGRF model and its plotting
6. Fourier transform: Generation of synthetic time series signals and obtain their Fourier transformations.
7. Solving differential equations using different numerical methods and their error analysis.
8. Development of a computer code to understand and quantify current-loop driven magnetic field.
9. Identification of geomagnetic storms from ground-based magnetometer data and space based satellite data, as well as standard indices.

SEMESTER II

SP008	Elective: Environmental Magnetism	3credit/45h

Unit 1: Introduction to Environmental Magnetism, Principles and applications of magnetism in environmental science, Magnetic Properties of Rocks and Minerals, types of magnetic behaviour, Magnetic Domains, Magnetic minerals in the environment, Igneous rocks, sedimentary materials and soils, Rock-magnetism, Induced and Remanent Magnetism, Magnetic susceptibility, types of magnetic remanence

Unit 2: Environmental sample collection, Laboratory experiments, data collection through instruments, sampling types, sampling protocols, sample preservation and transport, geological and geophysical samples preparation, measurement and instrumentation

Unit 3: Relative Paleointensity (RPI) determination from sediments-Psuedo-thellier approach, Anisotropy of magnetic Susceptibility (AMS), Depositional signals in continental and marine records, environmental magnetism and its application to Indian depositional settings, Magnetic susceptibility and depositional environments, magnetic mineralogical S-ratio and paleoclimate in sediments, application of environmental magnetic methods for paleoclimate, Tracking pollution sources and pathways using magnetic signatures

Text / Reference Books:

Introduction to Magnetism and Magnetic Materials – David Jiles

Environmental Magnetism – Thompson, R., and F. Oldfield, Allen and Unwin: Springer

Environmental Magnetism: a practical guide – J. Walden, F. Oldfield, J. and Smith

Geomagnetism: Solid Earth and Upper Atmosphere Perspectives – N. Basavaiah, Springer

Magnetism and Magnetic Materials – J.M.D. Coey

Research articles on modern magnetic materials and applications

SEMESTER II

SP008	Elective: Applied Geophysics	3credit/45h

Unit 1: Overview of Geophysics, key physical principles (gravity, magnetism, waves, heat), Interrelationship between geology and geophysics. Physical properties of minerals and rocks. Different types of surveys, grid and route surveys, profiling and sounding techniques. Scales of survey, Presentation of geophysical data. Geophysical Data Processing and Interpretation: Introduction to data processing techniques (e.g., inversion, modeling). Gravity and Magnetic Methods: Earth's gravitational and magnetic field. Gravity and magnetic surveys, instruments, anomalies, interpretation, and their applications.

Unit 2: Electrical & Electromagnetic Methods: Electric conductivity of rocks and unconsolidated sediments. Dielectric constants of rocks and unconsolidated sediments. Instrumentation, field procedure and interpretation using electrical methods. Electrical profiling and sounding using Wenner and Schlumberger configurations. Case studies. Electromagnetic fields, Basic principles of transient electromagnetic methods, depth of penetration, electromagnetic techniques (e.g., Magnetotellurics, Ground-Penetrating Radar etc). Applications in groundwater studies, mineral exploration etc

Unit 3: Seismic Methods: Wave propagation, seismic wave types (P-waves, S-waves, surface waves), and their relationship to Earth's structure.
Seismic Exploration: Seismic reflection and refraction techniques, field equipment, data acquisition, and processing. Application in oil and gas exploration
Heat Flow and Geothermal Gradients: Measurement of heat flow within the Earth's crust, geothermal gradients, and their use in understanding Earth's internal processes and geothermal energy exploration.

Text/Reference Books

Burger, Sheehan and Jones. Introduction to Applied Geophysics: Exploring the Shallow Subsurface. Cambridge university press.

Dobrin, M.B. An introduction to Geophysical Prospecting. McGraw-Hill, New Delhi. 1984
Fowler, C.M.R.; The Solid Earth: An introduction to Global Geophysics, Cambridge University Press
Gadallah M.R., Fisher R. and Fisher R.L. Exploration Geophysics. Springer, ISBN-978-3-540-85159-2
Kearey and Brooks An Introduction to Exploration Geophysics, Blackwell scientific Publication.
Lowrie, W. Fundamentals of geophysics. Cambridge University Press.

Ramachandra Rao, M.B. Outlines of Geophysical Prospecting - A Manual for Geologists, Prasaranga, University of Mysore, Mysore.
Robinson E.S.: Basic Exploration Geophysics. John Wiley & Sons.
Sharma PV. Geophysical methods in geology by. Elsevier.
Telford, W. M., Geldart, L. P., & Sheriff, R. E. Applied geophysics (Vol. 1). Cambridge university press.

SEMESTER II

SP009	Atmospheric Physics	3credit/45h

Unit 1: Basics of the atmospheric structure, electromagnetic radiation, absorption and emission. The radiation balance and the greenhouse gases, energy balance at the Earth's surface. Water balance. Hydrological cycle, water movements in ground and soil, transport of pollution in water and air, Systems of motions in atmosphere, hydrosphere and lithosphere on different scales.

Unit 2: Structure and Composition of the Lower Atmosphere, atmospheric layers(troposphere, tropopause, stratosphere, mesosphere), features of different layers, formation of ozone hole, pressure and density profiles, hydrostatic and hypsometric equations, vertical temperature profiles and lapse rates, lower-upper atmosphere coupling, gravity waves and planetary waves.

Unit 3: Ideal gas law, first and second laws of thermodynamics, potential temperature, Moist-air processes, saturation, dew/frost points, parcel theory, Cloud microphysics: nucleation, growth, precipitation mechanisms, Cloud formation dynamics; warm and cold microphysics, droplet/coalescence, ice-phase processes, electrification, artificial precipitation methods. Introduction to climate models.

Text / Reference Books:

Fundamentals of Atmospheric Physics by Murry L. Salby

An Introduction to Atmospheric Physics by David G. Andrews

Atmospheric Science: An Introductory Survey by Wallace and Hobbs

Physics of the Atmosphere and Climate (2nd ed.) by Murry L. Salby

SEMESTER II

SP010	Solar Physics	3credit/45h

Unit I: Overview of the Sun as a star, Structure and composition of the Sun, Energy generation (Nuclear fusion in the solar core), Solar irradiance, Standard solar model, probing solar interior through helioseismology, Solar atmosphere, photosphere, chromosphere, corona, temperature and density variations

Unit 2: Solar dynamo model, Magnetohydrodynamics (MHD) basics relevant to Solar Physics, Solar features, solar flares, Sunspot, coronal holes, coronal mass ejection, solar cycle, solar cycle variability, different periodicities, coronal heating problem

Unit 3: Structure and properties of the solar wind, Parker Solar wind model, interplanetary magnetic field, CME propagation, Space weather and its effects on Earth, implications of space weather, Introduction to different solar missions (Lagrangian points and orbiters, e.g., SOHO, SDO, Parker Solar Probe, Solar Orbiter) and related datasets

Text / Reference Books:

The Sun: An Introduction by Michael Stix

Astrophysics of the Sun by Harold Zirin

Physics of the Solar Interior and Atmosphere Edited by A.N. Cox, W.C. Livingston, and M.S. Matthews

The Sun: A Laboratory for Astrophysics, by J.T. Schmelz & J.C. Brown

The Solar Activity Cycle, by Andrei A. Pevtsov et al.

Physics of the Space Environment, by Tamas I. Gombosi

Introduction to Space Physics by Margaret G. Kivelson & Christopher T. Russell

Space Weather: Physics and Effects, by Volker Bothmer & I. Daglis

SEMESTER II

SP011	Ionospheric Physics	3credit/45h

Unit 1: Neutral upper atmosphere and its interaction with solar radiation, introduction to Earth's ionosphere, structure of ionosphere (different layers), density and temperature variations, Chapman's theory of photoionization, Loss and transport mechanisms, Influence of geomagnetic field on ionosphere, electrical conductivity.

Unit 2: Variability of ionosphere (different spatio-temporal variation), local and global distribution of plasma, ionospheric refractive index through Appleton-Hartree equation, propagation of radio wave through ionosphere, ionospheric scintillation, airglow, ionosonde experiment (principal and functioning), GPS/GNSS/ NavIC

Unit 3: Equatorial ionospheric electrodynamics, E region dynamo theory, Daytime equatorial electrojet, Equatorial ionization anomaly, F region dynamo, spread F, Pre-reversal enhancement, ionospheric F-region irregularities, plasma bubbles

Text / Reference Books:

Introduction to Ionospheric Physics, by Henry Rishbeth & Owen K. Garriott

The Earth's Ionosphere: Plasma Physics and Electrodynamics, by Michael C. Kelley

Ionospheric Radio, by Kenneth Davies

Physics of the Space Environment, By Tamas I. Gombosi

SEMESTER II

SP012	Space Weather	3credit/45h

Unit 1: Sun's features: solar wind, solar flare, coronal holes, sunspots, CME, solar flares, solar energetic particle. events, solar radio bursts. Interplanetary magnetic field (IMF), Definition & importance of space weather, Sun-Earth connection, geomagnetic storm, Historical examples of space weather events (e.g. Carrington event, Halloween storm 2003).

Unit 2: Space weather impacts on lower atmosphere, ionosphere, magnetosphere. Technological effects on satellites (GNSS/GPS), radio communications, transportation, electric grid, etc and socio-economic impacts. Effects on human health, Space weather and economy.

Unit 3: Significance of L1 point solar observations, Introduction to space weather data sets and indices. Space weather modelling (physics based, data based, and global MHD models), System design to reduce space weather risks. Global efforts for space weather forecasting models.

Text / Reference Books:

Storms from the Sun: The Emerging Science of Space Weather by Michael Carlowicz and Ramon Lopez, National Academies Press

Space Weather Effects and Applications edited by Anthea J. Coster, Philip J. Erickson, Louis J. Lanzerotti, Yongliang Zhang, Larry J. Paxton, American Geophysical Union

An Introduction to Space Weather by Mark Moldwin

Space Weather-Physics and Effects by Volker Bothmer , Ioannis A. Daglis, Springer Nature

Severe Space Weather Events--Understanding Societal and Economic Impacts-A Workshop Report, National Academies Press

Storms in Space by John W Freeman, Cambridge University Press

The 23rd Cycle: Learning to Live With a Stormy Star by Odenwald., Columbia University Press.

SEMESTER II

SP013	Magnetic observatory and Instrumentation (Lab Sessions)	2credit/60h

1. Realtime measurement of geomagnetic field. Measurement of short-term variations in Earth’s magnetic field using digital fluxgate magnetometer (DFM).
2. Hands on sessions: Geomagnetic data from IIG’s magnetic observatory network, world data centre, Intra magnet network
3. Measurement of declination and inclination of Earth’s magnetic field using DIM (Declination Inclination Magnetometer) and calculation of different components of Earth’s magnetic field.
4. Deriving the Dst-index from magnetometer observations from the four stations used internationally (Hermanus, Kakioka, Honolulu and San Juan).
5. Extraction of EEJ (Equatorial Electrojet) signatures from ground-based magnetometer data and their diurnal variations.
6. Hands on session on VLF experiment
7. Magnetic Susceptibility for Environmental Material Characterization
8. Electrical Resistivity Imaging of the Subsurface
9. Hands on Session on Airglow imager

10. Hands on Session on ionosonde experiment and its data analysis. Calculation of different ionospheric parameters (foF2, h'F, hmF2, etc.) using ionosonde
11. Installation of GPS and position marking during field survey

SEMESTER II

SP014	Computer Programming	1 credit

Overview of scientific programming languages (Python, C/C++, MATLAB, Fortran), Basics of algorithm development, flowcharts, and code structure, introduction to Linux environment, compilers, and debugging tools. Self-study programming courses (free) from https://swayam.gov.in/

Hands on sessions: MatLab, Python, AI-MI tools, Latex

SEMESTER II

SP015	Seminar + Comprehensive Viva	2 credit

Topic related to their core courses studied during Semester I and II.

SEMESTER III [Start]

SP016	Seminar	2 credit

Topic related to their thesis research

SEMESTER III [End]

SP017	Thesis Phase I	18 credit

Based on topic thesis work will be compiled with respective thesis guides/supervisors

SEMESTER IV [End]

SP018	Thesis Phase II	18 credit

Based on topic thesis work will be compiled with respective thesis guides/supervisors

SEMESTER IV [End]

SP019	Thesis Seminar-Viva	2 credit

Based on Thesis topic

Evaluation/Review Pattern:

Entry Level 1

Semester	Papers/Seminar	Marks
I	Six papers	80 Marks each =480
II	five papers Seminar + Comprehensive Viva	80 Marks each =400 120 Marks [Total 1000]
III	Seminar	100 Marks
IV	Thesis submission Thesis Seminar + Viva	800 Marks 100 Marks [Total 1000]

Entry Level 2

Semester	Papers/Seminar	Marks
I	Six papers	80 Marks each = 480
II	Thesis submission Thesis Seminar + Viva	400 Marks 120 Marks [Total 1000]

Distribution of marks

Entry level 1

Semester	Subject code	Subject title	Marks Theory Papers	Marks Internal Papers	Marks Total	credit
I	SP001	Mathematical Methods	70	10	80	3
	SP002	Electrodynamics	70	10	80	3
	SP003	Geomagnetism	70	10	80	3
	SP004	Plasma Physics	70	10	80	3
	SP005	Computational Physics	70	10	80	3
	SP006	Magnetospheric Physics	70	10	80	3
	SP007	Data Handling and Analysis (Lab Session)	Lab Sessions			2
II	SP008	Elective	70	10	80	3
	SP009	Atmospheric Physics	70	10	80	3
	SP010	Solar Physics	70	10	80	3
	SP011	Ionospheric Physics	70	10	80	3
	SP012	Space Weather	70	10	80	3
	SP013	Seminar + Comprehensive Viva	--	120	120	2
	SP014	Magnetic observatory and Instrumentation	Lab Sessions			2
	SP015	Computer Programming				1
III	SP016	Seminar	--	100	100	2
	SP017	Thesis Phase I	--	800	800	18
IV	SP018	Thesis Phase II				18
	SP019	Thesis Seminar-Viva	--	100	100	2

Entry level 2

I	SP001	Mathematical Methods	70	10	80	3
	SP002	Electrodynamics	70	10	80	3
	SP003	Geomagnetism	70	10	80	3
	SP004	Plasma Physics	70	10	80	3
	SP005	Computational Physics	70	10	80	3

	SP006	Magnetospheric Physics	70	10	80	3
	SP007	Data Handling and Analysis (Lab Session)	Lab Sessions			2
II	SP016	Thesis Phase II		400	400	18
	SP017	Thesis Seminar-Viva	--	120	120	2

Grading System:

Student has to obtain a minimum of 45% marks (equivalent CGPA of 4) in aggregate in the examination. Minimum 75% attendance is mandatory during the course. Students shall be graded, in each course, on a ten-point scale, which is as follows.

Grade	A+	A	A-	B+	B	B-	C+	C	C-	F
Grade Point	9	8	7	6	5	4	3	2	1	0

Conversion factor

The percentage of 55% is equivalent to CGPA of 5 and percentage of 35% is equivalent to CGPA of 3.

CGPA	Conversion	Percentage
8 to 9	5+CGPA × 10	85%-95.99%
7 to 7.99	5+CGPA × 10	75%-84.99%
6 to 6.99	5+CGPA × 10	65%-74.99%
5 to 5.99	5+CGPA × 10	55%-64.99%
4 to 4.99	5+CGPA × 10	45%-54.99%
3 to 3.99	5+CGPA × 10	35%-44.99%
2 to 2.99	5+CGPA × 10	25%-34.99%
1 to 1.99	5+CGPA × 10	15%-24.99%
0 to 0.99	5+CGPA × 10	0%-14.99%

Course code and Teaching Faculties:

Semester I (6 papers)

Subject code	Subject title	L	T	P	C	Faculty
SP001	Mathematical Methods	3	0	0	3	1. Dr. S. Sathishkumar (coordinator) 2. Dr. Sreeraj 3. Dr. Kuldeep Singh
SP002	Electrodynamics	3	0	0	3	1. Dr. Jayashree Bulusu (coordinator) 2. Dr. Naveen Parihar 3. Dr. Anjana
SP003	Geomagnetism	3	0	0	3	1. Dr. Geeta Vichare (coordinator) 2. Dr. S.P. Anand 3. Dr. Monica Rawat
SP004	Plasma Physics	3	0	0	3	1. Dr. Remya Bhanu (coordinator) 2. Dr. Indraj Singh 3. Dr. Anjan Paul
SP005	Computational physics	3	0	1	3	1. Dr. Devanandhan (coordinate) 2. Ayushi Srivastava
SP006	Magnetospheric Physics	3	0	0	3	1. Dr. Amar Kakad (coordinator) 2. Dr. Bharati Kakad 3. Dr. Neetasha Aarya
SP007	Data Handling and Analysis (Lab Session)	0	0	6	2	1. Dr. Gopi Seemala (coordinator) 2. Rohit Kumar Jha

						3. GVL Priyansa
	Total	15	0	7	20	

Semester II (5 papers, Seminar, Viva)

Subject code	Subject title	L	T	P	C	Faculty
SP008	Elective Environmental Magnetism Applied Geophysics	3	0	0	3	1. Dr. Deendayalan (coordinator) 2. Lakshmi 3. Dr. Priyeshu 1. Dr. Shantanu Pandey (coordinator) 2. Dr. Anand SP 3. Dr. Amitkumar 4. Dr. Ajish Saji
SP009	Atmospheric physics	3	0	0	3	1. Dr. Rajesh Singh (coordinator) 2. Dr. S. Sau, 3. Dr. S. Gurubaran (Guest)
SP010	Solar physics	3	0	0	3	1. Dr. Chinmay Nayak (coordinator) 2. Dr. Sumanjit Chakraborty 3. Dr. Subarna Mondol
SP011	Ionospheric Physics	3	0	0	3	1. Dr. S. Sripathi (coordinator) 2. Dr. Srinivas Nayak 3. Dr. Subrato Kundu
SP012	Space Weather	3	0	0	3	1. Dr. Tulasiram (coordinator) 2. Dr. Mala Bagiya

						3. Dr. Ankita Majrekar
SP013	Magnetic observatory and Instrumentation	0	0	6	2	1. Dr. Sujit Kumar Pradhan (coordinator) 2. Atul Kulkarni 3. Varun Dongre 4. Dr. Anil Iype
SP014	Computer Programming	0	0	3	1	1. Rajendra Rawat (coordinator), 2. Dr, Ajish Saji, 3. Guest Lecturer
SP015	Seminar +Comprehensive Viva	0	0	0	2	Review Panel
	Total	12	0	9	20	

<u>Semester III (Seminar, Thesis)</u>

Subject code	Subject title	L	T	P	C	Faculty
SP016	Seminar	0	0	0	1	Open
SP017	Thesis Phase I	0	0	0	17	Assigned Faculty
	Total	0	0	0	18	

<u>Semester IV (Thesis, Seminar)</u>

Subject code	Subject title	L	T	P	C	Faculty
SP018	Thesis Phase II	0	0	0	17	Assigned Faculty
SP019	Thesis Seminar-Viva	0	0	0	1	Open
	Total	0	0	0	18	

Guest lectures

Guest 1	August 2026
Guest 2	September 2026
Guest 3	October 2026
Guest 4	November 2026
Guest 5	February 2027
Guest 6	March 2027
Guest 7	April 2027
Guest 8	May 2027