।। सा विद्या या विमुक्तये ।।
स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड
"ज्ञानतीर्थ" परिसर, विष्णुपूरी, नांदेड - ४३१६०६ (महाराष्ट्र)
SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY NANDED
"Dnyanteerth", Vishnupuri, Nanded - 431606 Maharashtra State (INDIA)
Established on 17th September 1994 – Recognized by the UGC U/s 2(f) and 12(B), NAAC Re-accredited with 'A' Grade
ACADEMIC (1-BOARD OF STUDIES) SECTION
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E-mail: bos.srtmun@gmail.com

प्रस्तुत विद्यापीठीय संकुलातील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील द्वितीय वर्षाचे CBCS Pattern नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०२०—२१ पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, **दिनांक २० जून २०२० रोजी संपन्न झालेल्या ४७व्या मा. विद्या परिषद बैठकीतील विषय क्र.११/४७—२०२०** च्या ठरावानुसार **प्रस्तुत विद्यापीठीय संकुलातील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील द्वितीय वर्षाचे** खालील विषयांचे **C.B.C.S. (Choice Based Credit System) Pattern** नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०२०—२१ पासून लागू करण्यात येत आहेत.

01. M.Sc.-II Year-Botany
02. M.Sc.-II Year-Analytical Chemistry
03. M.Sc.-II Year-Industrial Chemistry
04. M.Sc.-II Year-Medicinal Chemistry
05. M.Sc.-II Year-Organic Chemistry
06. M.Sc.-II Year-Physical Chemistry
07. M.Sc.-II Year-Polymer Chemistry
08. M.Sc.-II Year-Computer Application
09. M.Sc.-II Year-Computer Network
10. M.Sc.-II Year-Computer Science
11. M.C.A.-II Year (Master of Computer Applications)
12. M.Sc.-II Year-Environmental Science
13. M.A./M.Sc.-II Year-Geography
14. M.Sc.-II Year-Geophysics
15. M.Sc.-II Year-Geology
16. M.A./M.Sc.-II Year-Mathematics
17. M.Sc.-II Year-Microbiology
18. M.Sc.-II Year-Physics
19. M.Sc.-II Year-Zoology
20. M.Sc.-II Year-Biotechnology
21. M.A./M.Sc.-II Year-Statistics

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या **www.srtmun.ac.in** या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
जा.क्र.: शैक्षणिक—१/परिपत्रक/पदव्युत्तर(संकुल)—सीबीसीएस अभ्यासक्रम/२०२०—२१/**५१३**

स्वाक्षरित/—
उपकुलसचिव
शैक्षणिक (१—अभ्यासमंडळ) विभाग

दिनांक : ०८.०८.२०२०.

प्रत माहिती व पुढील कार्यवाहीस्तव :
१) मा. कुलसचिव यांचे कार्यालय, प्रस्तुत विद्यापीठ.
२) मा. संचालक, परीक्षा व मूल्यमापन मंडळ यांचे कार्यालय, प्रस्तुत विद्यापीठ.
३) मा. संचालक, सर्व संबंधित संकुले, प्रस्तुत विद्यापीठ.
४) साहाय्यक कुलसचिव, पदव्युत्तर विभाग, प्रस्तुत विद्यापीठ.
५) उपकुलसचिव, पात्रता विभाग, प्रस्तुत विद्यापीठ.
६) सिस्टम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ.

Swami Ramanand Teerth Marathwada University

Syllabus

With effective from 2019 – 2020

M.Sc. Geophysics

2 Years (4 Semester Program)

Department of Geophysics
School of Earth Sciences
SRTM University
NANDED 431606
Maharashtra

M.Sc. Geophysics
Preamble: Syllabus and Examination Pattern

Syllabus of M.Sc. Geophysics program offered by the School of Earth Sciences has been prepared considering the syllabi for the UPSC examination, CSIR-NET examination, GATE and the requirements of the industry. The M.Sc. program in Geophysics is imparted to the students for two academic years consisting of four semesters. Candidates will be examined and evaluated on grade basis at the end of each semester in the different theory and practical papers as per the credits offered by each course.

The M.Sc. Geophysics program consists of (i) Core Subjects (ii) Subject Electives and (iii) Open Elective Courses. The Core Subjects shall be **75%** of the program (***with a total of 100 credits***), which are mandatory for all the students. Students can choose one Subject Elective per semester from the list of Subject Electives provided. A student has to take 8 credits of Open Elective courses within the 2-year term of the Program. The Open Electives can be selected from the Open Elective courses offered by the School of Earth Sciences *OR* offered by other Schools from the University Campus. Students are also encouraged to select Open Elective courses from National Educational Platforms such as MOOCS/NPTL/SWAYAM. If a student wishes, he/she can take a few extra courses, which will be considered as add-on credits.

In addition to class-room teaching and laboratory, the M.Sc. Geophysics program offers geological field training to the students. After completion of field training, students have to submit a filed report to the School. Intensive training/internships in the nationally reputed institutes shall also be provided to the M.Sc. Geophysics students. The semester breaks can also be utilized for the field training and internships.

All the Students will be assessed through Mid-Term (50%) and End-Term examinations (50%). Mode of assessment in the Mid-Term examinations consists of Tutorials, Home Assignments, Seminars, Field studies, Quizzes and Oral presentations. The End-Term examinations will be based on paper-pen pattern and laboratory experiments/calculations.

Every M.Sc. Geophysics student has to mandatorily submit dissertation thesis. The dissertation work is based on either new data generated for the proposed scientific problem *OR* based on available data sets using innovative ideas. The thesis should be based on sound methodology and well defined objectives. Through dissertation work the student should be well-versed with the literature on the chosen topic, independently define a scientific problem, carry out focused study on a research topic, analyze and interpret large data sets, independently write thesis / project proposal and present and defend the dissertation work. The Dissertation must be submitted by the end of fourth Semester with a Seminar presentation in the presence of faculty members, students and external examiners for the purpose of evaluation. The School of Earth Sciences strongly encourages the M.Sc. Geophysics students to present papers in the seminar, conferences and publish their dissertation work in SCI journals.

Program: M. Sc. Geophysics- Course Structure Under Choice Based Credit System (CBCS): Program Code: SES-S-GP-PG (14-2-5-01)

School of Earth Sciences, SRTM University

M. Sc. First Year (Semester I) to be implemented from 2020-21

S.N	Course	Code	Course title	Credits
1	Core	GP C 101	Mathematics	4
2	Core	GP C 102	Numerical Methods & Computer Programming	4
3	Core	GP C 103	Physics of the Earth	4
4	Discipline specific Elective (DSE) course for subject/School student (choose any one)	GP E 101	Basic Geology	3
		GP E 102	Earth System Sciences	
5	Generic Elective Course (Open Elective) (GEC) to be selected by the student from other Schools/departments in University	GP OE 101	Earthquakes	2
	Total Theory credits			17

Practical I Semester M.Sc. Geophysics

S.N	Course	Code	Course title	Credits
1	Core	GP C 104	Mathematics	2
2	Core	GP C 105	Numerical Methods & Computer Programming	2
3	Core	GP C 106	Physics of the Earth	2
4	Discipline specific Elective (DSE) course for subject/School student (choose any one)	GP E 103	Basic Geology	1
		GP E 104	Earth System Sciences	
5	Core	GP C 107	Seminar/Field Report	1
Total Practical credits				8
Total Credits (Theory & Practical)				25

GP C 101/PHYC101 Mathematics
Theory: 4 credits & Practical: 2 credits

Prerequisite:

- Must have studied Mathematics courses at his under graduate level

Course objective:

- This course objective is to enable the students to gain an understanding of the applications of mathematics to solve the geophysical problems

Course Content

Unit I: Vector Spaces and Matrices

Linear dependence and independence of vectors, Inner product, Schmidt's orthogonalization method. Matrices – Inverse, Orthogonal, Hermitian and unitary matrices, Transformation of vectors and matrices, System of linear equations, eigenvalues and eigenvectors of square matrix, diagonalization of a matrix, rotation matrix.

Unit II: Special functions

i) Legendre equation, Rodrigues formula for Pn(x), generation functions and recurrence relation, Associated Legendre polynomial.
ii) Bessel equation, Bessel function of first kind, generating functions and recurrence relation, Associated Legendre polynomial.
iii) Hermite Equation, generating function and recurrence relation for Hermite polynomial.
iv) Leguerre equation, generating function and recurrence relation, Rodrigue formula, Associated Lagurre polynomials.

Unit III: Fourier Series and Integral Transform

Fourier series: General properties of Fourier series, Simple applications, properties of Fourier series, convergence, integration, differentiation.
Fourier Transform, Laplace Transforms, Properties of Fourier and Laplace transforms (Linearity, first shifting and second shifting property), Fourier sine and cosine transforms, Fourier and Laplace transform of derivatives,
elementary Laplace transform, Inverse Fourier and Laplace transforms, shifting theorem, step function, Solution of simple differential equation using Laplace Transform technique.

Unit IV: Complex function and Calculus of Complex function

Definition of complex function, exponential function and properties, circular function and properties, hyperbolic function and properties, Inverse hyperbolic function, logarithmic function, limit of a complex function, continuity, derivative (theorem), analytic functions, harmonic functions, complex integration, Cauchy's theorem,

Cauchy's integral formula, Series of complex term-Taylor's series, Laurentz series. Zeros of an analytical function, Singularities of an analytical function (isolated, removable, poles and essential singularity), Residue Theorem-Calculus of residues.

GP C 104: Practical based on GP C 101 (2 Credits)

Course Outcome:

- At the end of the course the student will get knowledge to apply mathematics in geophysical modeling and inversion and other related aspects.

Prescribed and Reference Books

1. A. W. Joshi, Matrices and Tensors in Physics,
2. Mathematical Physics, B. S. Rajput
3. Higher Engineering Mathematics, By B. S. Grewal.
4. Mathematical Physics, S. L. Kakani.
5. Mathematical Physics, S. Chandra
6. Online material

GP C 102 /PHY C 102 Numerical Methods & Computer Programming
Theory: 4 credits & Practical: 2 credits

Prerequisite

- Must have studied Mathematics courses at his under graduate level and basic knowledge of computer programming

Course objective

- This course objective is to enable the students to gain an understanding of the Numerical Methods to solve the geophysical problems and to learn the programming skills

Course Content

Unit I: Curve fitting and interpolation

The Principle of Least squares, fitting a straight line, fitting a parabola, fitting an exponential curve, fitting curve of the form $y=ax^b$, fitting through a polynomial, Cubic spline fitting, Linear interpolation, difference schemes, Newton's forward and backward interpolation formula.

Roots of equation - Polynomial and transcendental equations, limits for the roots of polynomial equation. Bisectional method, false position method, Newton Raphson method, direct substitution method, synthetic division, complex roots.

Unit II: Numerical integration

Newton cotes formula, trapezoidal rule, Simpson's one third rule, Simpson's three eight rule, Gauss quadratics method, Monte Carlo method: **Solution of differential equation** Taylor series method, Euler method, Runge Kutta method, predictor-corrector method

Unit III: Solution of simultaneous equation:

Gaussian elimination method, pivotal condensation method, Gauss-Jordan elimination method, Gauss-Seidal iteration method, Gauss-Jordan matrix inversion method, Gaussian-elimination matrix inversion method ; **Eigen values and eigenvectors of a matrix-** Computation of real Eigen values and corresponding eigenvectors of a symmetric matrix, power method and inverse power method. **Partial differential equations-** Difference equation method over a rectangular domain for solving elliptic, parabolic and hyperbolic partial differential equation

Unit IV:**C- Programming**

Elementary information about digital computer principles, compliers, interpreters, and operating systems, C programming, flow charts, integer and floating point arithmetic, expression, build in functions, executable and non-executable statements, assignment, control and input-output elements, user defined functions, operation with files: pointers, **Random numbers**:

Random numbers, Random walk, method of importance sampling.

GP C 105 Practical based on GP C 102 (2 Credits)

Course Outcome:

- At the end of the course the student will get knowledge of numerical techniques to solve geophysical problems, the student also acquire skills in developing computer programs in geophysical applications. The knowledge acquired in this course will be useful acquire knowledge of geophysics in coming semesters and also after graduation.

Prescribed and Reference Books

1. H. M. Antia: Numerical methods for scientists and engineers.
2. Suresh Chandra Computer Applications in Physics with FORTRAN, BASIC and C, Narosa Publishers
3. Vetterming, Teukolsky, press and Flannery: Numerical recipes.
4. Sastry: Introductory method of numerical analysis.
5. Rajaraman: Numerical analysis.
6. Numerical Computational methods, P. B. Patil and U. P. Verma.
7. Numerical methods and computation – B. K. Bafna.
8. Advanced engineering mathematics – Erwin Kreszing 5^{th} or 7^{th} edition john Willey and sons inc.
9. C Programming : Balagurusamy
10. Suresh Chandra Applications of Numerical Techniques with C Narosa Publishers.
11. Online material

GP C 103 Physics of the Earth
Theory: 4 credits & Practical: 2 credits

Prerequisite

- Basic knowledge about physics and material properties

Objective:

- This course's objective is to introduce the student about the basic physical process and its applications in understanding the Earth and its process. This course forms as a foundation course for a student to gain overall understanding of the Geophysics subject and its approach.

Course Content

Unit I:
History of development and scope of geophysics, hypotheses for the origin of solar system, Kepler's law of planetary motion, planet and satellites of the Solar system and their characteristics, Internal constitution of the earth, Characteristics of Crust, Mantle and Core, lithosphere, and Asthenosphere.

Unit II:
Importance of heat flow, thermal history of the earth, sources of heat generation and temperature distribution inside the earth, Radiometric dating principles and ages of rocks and the earth.

Unit III:
Origin of geomagnetic field, secular variations and westward drift, geomagnetic time scale, geomagnetic storms, Earth's current, sun spot, solar flares, lunar and solar variations, Palaeomagnetic studies of rock samples and their applications in geophysics, polar wandering, reversals of geomagnetic field. Geomagnetic time scale

Unit IV:
Gravity and Figure of the Earth, international gravity formula and rotation of the Earth. Concept of isostasy, Airy, Heiskanan and Pratt-Hayford hypotheses.

GP C 106 Practical based on GP C 103 (2 Credits)

Course Outcome:

- At the end of the course the student will get knowledge of physical concepts and Earth dynamics. With the knowledge acquired in this course the student gets foundations in understanding the subject in further semesters.

Prescribed and Reference Books

1. Planet Earth by Press and Siever
2. Fundamentals of Geophysics by Lowrie
3. The Solid Earth by Fowler
4. Introduction to seismology by Peter Shearer
5. Introduction to Geophysics by Howell :
6. Physics and Geology, by Jacobs and Russel
7. Physics of the earth, by Stacey
8. The interior of the earth, by M.H.P. Bott
9. Topics in Geophysics, by P.J. Smit
10. Online material

GP E 101 Basic Geology
Theory: 3 credits & Practical: 1 credit

Prerequisite

- Basic knowledge of geography or geology

Objective:

- This course objective is to introduce the student about the basics of geology which is essential as the geophysics is applications of physics to solve geological processes. At the end of the course the student gains the knowledge of essentials of geology to study geophysics.

Course Content

Unit I:
Introduction to geology, Geology as a fundamental science; branches of geology and relationships with other branches of science, weathering agents, Introduction to geomorphology Folds, faults, unconformities, joints and their classification, Geological time scale , *Earth System:* Lithosphere, Hydrosphere, Cryosphere and Atmosphere and their interactions

Unit II:
Mineralogy : Mineral - its definition and mode of occurrence, physical properties of minerals like form, colour, lustre, streak, cleavage, fracture, hardness and specific gravity, Physical characters and chemical composition of different rock forming minerals.

Unit III:
Petrology : Rock – its definition; classification and distinguishing characteristics of Igneous, Sedimentary and Metamorphic rocks; forms of Igneous rocks, elementary ideas regarding formation; Texture and structure of Igneous, Sedimentary and Metamorphic rocks; Brief petrographic description and occurrences different rocks :

GP E 103 Practical based on GP E 101 (1 Credit)

Course Outcome:

- Very essence of geophysics is to apply the physical principles to understand the geological processes. After the course the student gets basic knowledge of geology in tune with the geophysical applications. The knowledge acquired in this course will be useful to acquire knowledge of geophysics and its complete understanding in coming semesters and also after graduation.

Prescribed and Reference Books

1. The Earth: Press and Seiver
2. Blue Planet: Skinner and Porter
3. Physical Geology: Arthur Holmes
4. A Text Book of Geology: P.K. Mukherjee
5. Engineering Geology: Purbin Singh
6. Earth Materials: Klein and Philpotts
7. Principles of Petrology by Tyrrell
8. Elements of Mineralogy by Read & Rutley's
9. Online material

GP E 102 Earth System Sciences
Theory: 3 credits & Practical: 1 credit

Prerequisite

- Basic knowledge of geography or geology, This course is recommended for those who already studied geology in their graduation and are confident about their concepts about geology

Objective:

- This course objective is to introduce the student about the understanding of the Earth System, various components and its interrelation. This helps the student to gain knowledge about the overall interaction and processes of various systems of the Earth.

Course Content

Unit I:
Earth as a planet Holistic understanding of dynamic planet 'Earth' through Astronomy, Geology, Meteorology and Oceanography. Introduction to various branches of Earth Sciences. General characteristics and origin of the Universe, Solar System and its planets. Earth and Planetary system, size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect

Unit II:
Plate Tectonics Concept of plate tectonics, sea-floor spreading and continental drift Geodynamic elements of Earth- Mid Oceanic Ridges, trenches, transform faults and island arcs Origin of oceans, continents, mountains and rift valleys Earthquake and earthquake belts Volcanoes- types, products and their distribution.

Unit III:
Lithosphere, Hydrosphere and Atmosphere, Internal structure of the Earth, isostasy; elements of seismology; physical properties of the interior of the earth; continents and continental processes Introduction to Earth and formation theories. Seismicity and earth's interior.Compositional and Rheological divisions of Earth; crust, mantle and core; discontinuities. Earth's magnetic field, paleomagnetism, continental drift, plate tectonics.

GP E 104 Practical based on GP E 102 (1 Credit)

Course Outcome:

- At the end of the course the student gains the knowledge of Earth and understanding the interrelation between various spheres the knowledge acquired in this course will be useful to acquire knowledge of geophysics and its complete understanding in coming semesters and also after graduation.

Prescribed and Reference Books

1. The Earth: Press and Seiver
2. Blue Planet: Skinner and Porter
3. Physical Geology: Arthur Holmes
4. A Text Book of Geology: P.K. Mukherjee
5. Earth Materials: Klein and Philpotts
6. Holmes' principles of physical geology. Taylor & Francis. By Duff, P. M. D., & Duff, D. (Eds.).
7. Planet earth: cosmology, geology, and the evolution of life and environment. Cambridge University Press: Emiliani, C
8. Oceanography: A view of the earth by Gross, M. G.
9. Online material

GP OE 101 Earthquakes
Theory: 2 Credits

Prerequisite

Interest in study of the Earth

Course Objectives:

The objective of this course is to introduce basics of Earthquakes.

Course Content

Unit I:
Earthquake types and its characteristics, seismic waves, magnitude, epicenter, focus, Internal structure of Earth, Faults, Plates, Lithosphere and its dynamics

Unit II:
Earthquake intensity, seismic zoning of India, major Earthquakes in India, local seismicity, how to use online portals for current and past earthquake information from earthquake catalogues, Preparedness plan for self and family.

Course Outcomes (CO)

- At the end of the course the students will gain basic understanding of earthquakes and preparedness and precautions.

Prescribed and Reference Books

1. Earthquakes, N Purnachandra Rao, APAS
2. The Earth: Press and Seiver
3. Fundamentals of Geophysics, William Lowrie
4. An Introduction to Seismology, Earthquakes and Earth structure By Stein & Wysession
5. Engineering Seismology By Agarwal
6. Microearthquake Seismology and Seismotectonics of South Asia, by J R Kayal
7. USGS web portal
8. NCS Web portal
9. Online material

Program: M. Sc. Geophysics- Course Structure-Under Choice Based Credit System (CBCS): Program Code: SES-S-GP-PG (14-2-5-01)

School of Earth Sciences, SRTM University

M. Sc. First Year (Semester II) Revised draft to be implemented from 2020-21

S.N	Course	Code	Course title	Credits
1	Core	GP C 201	Gravity Method	4
2	Core	GP C 202	Signal processing	4
3	Core	GP C 203	Electrical Methods	4
4	Discipline specific Elective (DSE) course for subject/School student (choose any one)	GP E 201	Applied Geology	3
		GP E 202	Geo dynamics	
5	Generic Elective Course (Open Elective) (GEC) to be selected by the student from other Schools in University	GP OE 201	Basics of Geophysics	2
	Total Theory credits			17

Practical II Semester M.Sc Geophysics

S.N	Course	Code	Course title	Credits
1	Core	GP C 204	Gravity Method	2
2	Core	GP C 205	Signal processing	2
3	Core	GP C 206	Electrical Methods	2
4	Discipline specific Elective (DSE) course for subject/School student (choose any one)	GP E 203	Applied Geology	1
		GP E 204	Geo dynamics	
5	Core	GP C207	Seminar/Field Report	1
Total Practical credits				8
Total credits (Theory & Practical)				25

GP C 201 Gravity Method
Theory: 4 credits & Practical: 2 credits

Prerequisite

Basic Physical concepts of gravitational field of the Earth

Objective:

This course is intended to discuss about the gravitational field of the Earth and its applications in Geophysics. Density variations of Earth materials, gravity method concepts, instrumentation, data acquisition, data processing, data analysis and data interpretation of gravity data and its applications.

Course Content

Unit 1:

Earth's Gravity Field, principle and Characteristics, Properties of Newtonian potential, Laplace's and Poisons'' equations, Green's theorem, Gauss law - Rock densities and factors affecting density, density measurement techniques of the samples, concept of gravity anomaly, gravity prospecting instruments, zero length spring, Worden & Lacoste gravimeters, Absolute gravimeters.

Unit II:

Gravity units, concept of geod and spheroid, gravity base, collection of gravity data, drift correction, reduction of gravity, Bouguer gravity anomalies, airborne and ship borne gravimetry, Isostacy.
Plan of gravity surveys, presentation of gravity data, Concept of noise, regional and residual anomalies, methods of calculation, upward and downward continuation, derivative calculations, Fourier transformations and Harmonic analysis. Ambiguity in gravity

Unit III:

Interpretation of gravity data- qualitative interpretation, identification of two and three dimensional bodies, structural features, quantitative interpretation, conventional methods of interpretation techniques- thumb rules and methods of characteristic curves, gravity anomalies of geophysical models- point mass, line mass, discs, cylinders, sheets, faults, slabs, irregular shaped bodies.
Unit IV:

Computer based techniques- Forward modeling and inversion – principles of inversion- computer aided interpretation of gravity anomalies of different regular, irregular shaped bodies, sedimentary basins. Application of gravity in mineral and oil exploration, geological mapping, groundwater and geotechnical engineering – some case studies. Mass estimation in gravity.

GP C 204: Practical based on GP C 201 (2 Credits)

Course Outcome:

At the end of the course the student get knowledge about gravitational field and its applications. The student will be in a position to use gravitational methods in the geoexploration, resource evaluation, figure of the Earth and geological mapping.

Prescribed and Reference Books

1. Gravity and Magnetic methods by Rao B.S.R and Murthy I.V.R
2. Gravity and Magnetic interpretation in Exploration Geophysics by I.V.R. Murthy
3. Applied geophysics by W.W. Telford
4. Introduction to Geophysical prospecting by M.B. Dobrin
5. An Introduction to Geophysical Exploration by Philip Kearey , Michael Brooks and Ian Hill
6. Fundamentals of Geophysics by William Lowrie
7. Net Browsing

GP C 202 Signal processing
Theory: 4 credits & Practical: 2 credits

Prerequisite

Basic Physical concepts of gravitational field of the Earth

Objective:

The objective of this course is that students learn how to reconstruct continuous signals from sampled ones, filtering techniques, discrete Fourier transforms in the analysis and processing of digital signals.

Course Content

Unit I:

Introduction, definition of signal and noise, types of signals, Analog and Digital signals, Sampling theorem Digitization of geophysical data. Nyquist frequency and Aliasing. Errors of digitization.

Unit II:

Fourier series, Gibbs phenomenon, fourier transforms, time and frequency domain, fourier transforms and some important functions – rectangular, periodic, exponential, singularity, Spectral analysis, FFT.

Unit III:

Time series analysis, correlation, convolution, impulse response and transfer function, Z-transform Hilbert transform, wavelets. Waveform processing, power spectrum, Wiener- Khintchin theorem.

Unit IV:

Windowing, Filtering techniques – design - digital and frequency filters; Amplitude and phase responses of filters, low pass, hipass and band pass filters, butter worth filters, recursive and non recursive filters, Wiener filters, Deconvolution and predictive deconvolution. Generalised linear inverse method.

GP C 205: Practical based on GP C 202 (2 Credits)

Course Outcome:

At the end of the course the student will get knowledge for geophysical data processing of both continuous and discrete data. After completing the course the student will get knowledge in the data processing of gravity, magnetic and seismic signals, which the student will be dealing in further semesters. The students become adept at using discrete Fourier transforms in the analysis and processing of digital signals.

Prescribed and Reference Books

1. Marcus Bath, 1974, Spectral Analysis in Geophysics, Elsevier.
2. A Populis, 1962, The Fourier integral and its applications, MC Graw Hill Publishers.
3. J.F. Clarebout, 1976, Fundamentals of geophysical data processing.Mc. Graw Hill Publishers.
4. E.R. Kanasewich, 1975, Time sequence analysis in geophysics, The University of Alberta Press.
5. E.A. Robinson and S. Treitel, 1983, Digital Seismic inverse methods, D. Reidel Publishing Co.
6. R.N. Bracewell, 1986, Fourier transform and its applications, Mc Graw Hill Publishers.
7. J.B. Thomas, 1969, An introduction to statistical communication Theory, John – Wiley Publishers,
8. A.V. Oppenheium and R. W. Schafer. Digital signal processing, Prentice hall of India.
9. Silvia, M.T. and Robinson, E.A. Deconvolution of geophysical time series in the exploration for Oil and Natural gas. Elsevier Scientific Publishing Co.
10. Tarantola A 1984, Inverse Problem Theory, Elsevier, Amsterdam.
11. Online material

GP C 203 Electrical Methods
Theory: 4 credits & Practical: 2 credits

Prerequisite

- Basic Physical concepts of Electricity,

Course Objective:

- This course is intended to impart knowledge about the various electrical properties of Earth materials, methods developed based on the electrical properties, instrumentation, data acquisition, data processing, data analysis and data interpretation of electrical data and its applications. .

Course Content

Unit I:

Electrical fields in geophysics, Principles and classification of Electrical methods of prospecting, current and potentials, electrical properties of the rocks, current flow in ground, Electric conduction in rocks, factors affecting electrical conduction in rocks, isotropy, anisotropy, principles of equivalence, Dar Zarrouk parameters- Longitudinal conductance and transverse resistance.

Unit II:

Self potential (SP) – origin, measurement, field technique, SP anomalies over different models, interpretation of SP anomalies. Applications of SP method.
Resistivity methods – concept of resistance and resistivity. Concept of true and apparent resistivity. Apparent resistivity for multi layer Earth and super position.

Unit III:

Different Electrode arrays – Wenner, Schlumberger, Dipole-diploe – Geometric factor. Vertical Electrical Sounding (VES), Horizontal Profiling techniques. Field procedures.
Types of VES curves- Interpretation-Curve matching, partial curve matching techniques- direct and indirect methods of interpretation – resistivity transform functions.
Resistivity profiling over fault, vertical contacts, buried 2-d and 3-D bodies, estimation of overburden thickness. Application of resistivity methods in various applications like groundwater, mineral, geotechnical and geological mapping.

Unit IV:

Induced polarization (IP) method: Basic concepts, source of IP. Over voltage and Induced polarization. Membrane polarization and electrode polarization. IP measurements- Time domain measurements – Chargeability and delay time. Frequency domain measurements – percentage frequency effect (PFE), metal conduction factor. Relation between time and frequency domain IP measurements. Field procedures – collection and presentation of data – pseudo section plotting – complex resistivity. Magnetic Induced Polarization (MIP) method. Applications of IP in exploration and geological applications.

GP C 206: Practical based on GP C 203 (2 Credits)

Course Outcome:

- At the end of the course the student gets knowledge about Electrical methods and its applications. The student will be in a position to use Electrical methods in the geoexploration, resource evaluation, figure of the Earth and geological mapping.

Prescribed and Reference Books

1. Applied geophysics by W.W. Telford
2. Introduction to Geophysical prospecting by M.B. Dobrin
3. An Introduction to Geophysical Exploration by Philip Kearey, Michael Brooks and Ian Hill
4. Applied Geophysics, Telford, et. al., revised edition
5. Electrical methods of Geophysical Prospecting, Keller and Frischknecht
6. Mining Geophysics, Parasnis
7. Outline of Geophysical Prospecting, M.B. Ramchandra Rao.
8. Field Geophysics, John Milsom
9. Net browsing

GP E 201 Applied Geology
Theory: 3 credits & Practical: 1 credit

Prerequisite

- Basic knowledge of geology, of undergraduate course are must have studied Basic geology/ Earth System Studies course at first semester in this school

Course Objective:

- This course objective is to introduce the student about the geology which is essential as the geophysics is applications of physics to solve geological processes. At the end of the course the student gains the knowledge of essentials of geology and relevant geological inputs to study geophysics.

Course Content

Unit I:

Petrology: Different kinds of rocks – igneous, sedimentary and metamorphic rocks - their physical properties and its variations, factors affecting the physical properties of different rocks

Folds: Nomenclature of folds, Types of folds, origin of folds, identification of folds in the field

Unit II:

Structural geology - Faults, folds and joints: Nomenclature, types, mechanisms, identification in the fields of Faults, Types of Faults, Fault Mechanism, Identification of Faults in the field. Geological structures and associated physical processes.

Unit III:

Geotectonics: Convection currents, Plate, types of plates, plate boundaries, causes of plate movement, Rifting of continent, Subduction zone, island arcs, mid oceanic ridges, Hot Spot, Formation of Deccan Shield, Collision and its types,

GP E 203: Practical based on GP E 201 (1 Credit)

Course Outcome:

- After the course the student gets basic knowledge of geology in tune with the geophysical applications. The knowledge acquired in this course will be useful to gain skills in geophysics and its complete understanding in coming semesters and also after graduation.

Prescribed and Reference Books

1. Fundamentals of Structural Geology: Pollard & Fletcher
2. Foundations of Structural Geology: R. G. Park
3. Structural Geology: Marland Pratt Billings
4. The Techniques of Modern Structural Geology: John G. Ramsay
5. Introduction to the Structure of the Earth: Edgar Winston Spencer
6. Flow Processes in Faults and Shear Zones: G. Ian Alsop
7. Plate Tectonics: Continental Drift and Mountain Building: Wolfgang Frisch, Martin MesChede, Ronald C. Blakey
8. Plate Tectonics: Kent. C. Condie
9. Plate Tectonics: A. Cox and R.B. Hart
10. Mantle convection: Plate Tectonics and Global Dynamics: W.R. Peltier
11. When Did Plate Tectonics Begin on Planet Earth: Kent. C. Condie and Victoria Pease
12. Net browsing

GP E 202 Geodynamics
Theory: 3 credits & Practical: 1 credit

Prerequisite

- Basic knowledge of geology, of undergraduate course are must have studied Basic geology/ Earth System Studies course at first semester in this school

Course Objective:

- This course objective is to introduce the student about the dynamic processes associated with the Earth. The objective is to teach both exogenic and endogenic processes in relation to the understanding of geophysics.

Course Content

Unit I:

Geology and geodynamics, Lithosphere, hydrosphere and atmosphere, endogenic and exogenic forces, Internal constitution of the earth, Crust, mantle and core, characteristics of lithosphere and asthenosphere, causes of geodynamical process, geodynamic models

Unit II:
Rock forming minerals, Classification of rock formations, rock cycle and geodynamic processes, Geological action of agents like water and wind, weathering, soil formation, atmosphere and climatic changes, Geomagnetism, paleomagentism

Unit III:

continental drift, ocean floor spreading, plate tectonics and its geological implications, new global tectonics and plate margin process, geomagnetic time scale, Benioff zones, oceanic ridges, evolution of the triple junction, trenches and island arcs, hot (20) spots, geodynamics of Indian subcontinents and formation of Himalayas, 900 E ridge, concept of isostasy, Airy, Heiskanan and Pratt-Hayford hypotheses

GP E 204: Practical based on GP C 202 (1 Credits)

Course Outcome:

- After the course the student gets basic knowledge of dynamic processes of the Earth in tune with the geophysical applications. The knowledge acquired in this course will be useful to gain skills in geophysics and its complete understanding in coming semesters and also after graduation.

Prescribed and Reference Books

1. Fundamentals of Structural Geology: Pollard & Fletcher
2. Introduction to the Structure of the Earth: Edgar Winston Spencer
3. Flow Processes in Faults and Shear Zones: G. Ian Alsop
4. Plate Tectonics: Continental Drift and Mountain Building: Wolfgang Frisch, Martin MesChede, Ronald C. Blakey
5. Plate Tectonics: Kent. C. Condie
6. Mantle convection: Plate Tectonics and Global Dynamics: W.R. Peltier
7. When Did Plate Tectonics Begin on Planet Earth: Kent. C. Condie and Victoria Pease
8. Geomagnetism by Jacob
9. The Earth: Press and Seiver
10. Blue Planet: Skinner and Porter
11. Physical Geology: Arthur Holmes
12. A Text Book of Geology: P.K. Mukherjee
13. Oceanography: A view of the earth by Gross, M. G.
14. Online material

GP OE 201 Basic Geophysics
Theory: 2 Credits

Prerequisite

Interest in study of the Earth using Physics.

Course Objectives:

The objective of this course is to introduce basics of geophysics and philosophy of geophysics as a science.

Course Content

Unit I:

Basic Philosophy of Geophysics and Geology, Major geophysical methods and physical properties, Passive and active fields ,Concept homogenous in geophysics, Gravitational field of the Earth, Figure of the Earth, reference spheroid and geoid, Basics of Geomagnetism and Paleomagnetism, Earth's magnetic field and components, Basic electrical properties in the use of Geophysics, geophysical measurements and different platforms,

Unit II:

Particle, Atoms, Radioactivity, Disintegration by alpha, beta and gamma particles, Half life, Isotopes and age-dating and its uses in dating rocks, Heat Flow
Elasticity and Elastic modulii, Stress and strain and their relationship, Earthquakes, seismic waves and its properties, Internal Constitution of Earth, introduction to plate tectonics

Course Outcomes:

At the end of the course the students will gain basic understanding of the philosophy of geophysics as a study. This course makes the students to understand the importance and role of the geophysics in nation building and society.

Prescribed and Reference Books

1. Physics for geologists by Richard Chapman
2. Outline of Geophysical Prospecting, M.B. Ramchandra Rao.
3. Outlines of Exploration Geophysics, VLS Bhimasankaram, AEG Publication
4. Exploration Geophysics by Kaul and Bhattachrya, AEG Publication
5. Geophysical methods in geology, G. R. Foulger & C. Peirce
6. Relevant recommended material from Web
7. The Dynamic Earth System, Patwardhan
8. Online material

Program: M. Sc. Geophysics- Course structure - Under Choice Based Credit System (CBCS): Program Code: SES-S-GP-PG (14-2-5-01)

School of Earth Sciences, SRTM University

M. Sc. Second Year (Semester III) to be implemented from 2020-21

S.N	Course	Code	Course title	Credits
1	Core	GP C 301	Magnetic Method	4
2	Core	GP C 302	Hydro-Geology	4
3	Core	GP C 303	Seismology	4
4	Discipline specific Elective (DSE) course for subject/School student (choose any one)	GP E 301	Remote sensing	3
		GP E 302	Geographical Information Systems	
5	Generic Elective Course (Open Elective) (GEC) to be selected by the student from other Schools in University	GP OE 301	Near Surface Geophysics	2
	Total Theory Credits			17

Practical III Semester M.Sc. Geophysics

S.N	Course	Code	Course title	Credits
1	Core	GP C 304	Magnetic Method	2
2	Core	GP C 305	Hydro-Geology	2
3	Core	GP C 306	Seismology	2
4	Discipline specific Elective (DSE) course for subject/School student (choose any one)	GP E 303	Remote sensing	1
		GP E 304	Geographical Information Systems	
5	Core	GP C 307	Seminar/Field Report	1
	Total Practical credits			8
Total Credits (Theory & Practical)				25

GP C 301 Magnetic Method
Theory: 4 credits & Practical: 2 credits

Prerequisite

- Basic Physical concepts of magnetism and geomagnetism

Course Objective:

- This course is intended to discuss about the magnetic field of the Earth, potentials and its applications in Geophysics. . Magnetic field variations of Earth and its materials, concepts of magnetic methodology, instrumentation, data acquisition, data processing, data analysis and data interpretation of magnetic data and its applications. Concepts of palaeomagnetism and rock magnetism.

Course Content

Unit I:

Earth's main magnetic field, origin and distribution, Elements Geomagnetic field Coulombs law of magnetic force and fields, magnetic moments, intensity of magnetization, magnetic potential, Units of measurement, Laboratory determination of susceptibility, origin and concept of magnetic anomalies, concepts of Induced and Remnant magnetism. Concepts of Palaeomagnetism, .NRM, magnetic reversals, introduction to geological time scale, applications of Paleomagnetism-Anisotropic Magnetic Susceptibility (AMS), concepts and definitions,

Unit II:

Principle of magnetic prospecting, Magnetic prospecting Instruments: Flux gate magnetometers, vertical and total field magnetometers, Proton- precision magnetometers, Plan of magnetic surveys, Magnetic data collection process and its corrections; air borne and ship borne magnetic surveys

Unit III:

Regional & residual separation, Upward and downward continuation techniques, Interpretation of magnetic data, Qualitative and quantitative interpretation, Magnetic anomalies over simple geometric bodies and irregular bodies,

Unit IV:

Principles of Inversion and Modeling, Inversion of magnetic anomalies of simple geometric bodies, 2D polygonal bodies, magnetic interfaces, time domain and frequency domain techniques. Applications of magnetic method for geological mapping and exploration,.

GP C 304: Practical based on GP C 301 (2 Credits)

Course Outcome:

- At the end of the course the student get knowledge about geomagnetism, magnetic field and its applications. The student will be in a position to use magnetic methods in the geoexploration, resource evaluation, evolution of the Earth and geological mapping.

Prescribed and Reference Books

1. Gravity and magnetics in oil prospecting, L.L. Nettleton
2. Gravity and magnetic methods, Rao, B.S.R and Murthy, I.V.R
3. Gravity and magnetic Interpretation in Exploration Geophysics, I.V. RadhakrishnaMurthy
4. Applied Geophysics, W.W. Telford et. al
5. Introduction to Geophysical prospecting, M.B. Dobrin
6. Interpretation theory in Applied Geophysics, F.S. Grant and West
7. Environmental Magnetism By Roy Thompson and Frank Oldfield
8. Anisotropic Magnetic Susceptibility By Tarling and Hrouda
9. Principles and Applications of Paleomagnetism By D.H. Traling
10. Online material

GP C 302/GEO-C302 Hydrogeology
Theory: 4 credits & Practical: 2 credits

Pre-requisites:

Basic (10+2) knowledge of geology, chemistry and physics.

Course objectives:

1. To understood the hydro-geological cycle.
2. Occurrence of groundwater on the planet earth.
3. To study the groundwater aquifers, hydro geological properties, and movement of groundwater.
4. Exploration of groundwater occurrence in different geological formations.
5. To develop the writing skills based on research pattern/report writing which is useful in research institutes/govt. organizations/Pvt. organizations
6. To develop the skills of individual student so that he/she will be competent enough to get job in this field of specialization.

Course content

Unit I:

Hydrological cycle; Occurrence and distribution of groundwater; Aquifer classification and characteristics of aquifers, Hydrological properties of rocks-Porosity, permeability, hydraulic conductivity, specific yield, storage coefficient, transmissibility, hydraulic resistivity, hydraulic diffusivity.

Unit II:

Classification of rocks from hydrological view- Properties; groundwater conditions in different geological formations. Aquifer parameter analysis; Darcy's Law in homogenous and heterogeneous media; Bernoulli equation; Reynold's number; pumping test and aquifer evaluations; Coastal conditions- seawater intrusion and its control;

Unit III:

Groundwater management; methods of recharge; artificial recharge; water budgeting and evaluation of perennial yield; Urbanization and demands on water; Water logging and conjunctive use; excessive use and alkalinity-saltation; Methods of water conservation; sustainable watershed development; groundwater level fluctuations; land subsidence; impact of global climate change on groundwater.

Unit IV:

Groundwater chemistry: Chemical characteristics of groundwater in relation to various uses – domestic, industrial and irrigation; Radioisotopes in hydro-geological studies; Groundwater contamination and problems of arsenic, fluoride and nitrates.

Groundwater exploration: Surface investigation of groundwater - geologic, remote sensing, electrical resistivity, seismic, gravity and magnetic methods; sub-surface investigation of groundwater - test drilling, resistivity logging, spontaneous potential logging, radiation logging.

GP C 305: Practical based on GP C 302 (2 Credits)

Course outcomes:

At the completion of the course student would be able to

1. Understand Water-bearing formations.
2. Understand and model the flow of groundwater.
3. Explain chemistry of groundwater as controlled by natural and anthropogenic processes.
4. Detect groundwater potential and understand its management.
5. Analyze water for different chemical components.
6. Graphically represent variations groundwater chemistry.

Prescribed and Reference Books

- Geochemistry, Groundwater and Pollution by C.A.J. Appelo
- Geophysical Prospecting For Groundwater by Sankar Kumar Nath
- Ground Water and Wells by F.G. Driscoll
- Ground Water by H.M. Raghunath
- Ground Water Hydrology by D.K. Todd
- Groundwater Geochemistry by J. Merkel Broder
- Groundwater Geophysics in Hard Rock by Prabhat C. Chandra
- Groundwater Prospecting and Management by H. P. Patra, Shyamal Kumar Adhikari, and Subrata Kunar
- Hydrogeology by S.N. Davies and R.J.N. Dc-West
- Modern Groundwater Exploration: Discovering New Water Resources in consolidated Rocks Using Innovative Hydrogeologic Concepts, Exploration, Drilling, Aquifer Testing and Management Methods by Jay H. Lehr and Robert A. Bisson

GP C 303 Seismology
Theory: 4 credits & Practical: 2 credits

Prerequisite:

- Basic Physical concepts of elastic properties of different materials, internal constitution of the earth

Course Objective:

- The objective is to provide knowledge about earthquakes, seismology, solid foundation in principals of seismic wave generation and propagation through theory and applications of modern analysis techniques, seismic data acquisition techniques.

Course Content

Unit I:

Introduction to earthquake phenomena, concept of focus, focal depth, epicentre, intensity and magnitude scales and energy of earthquakes, foreshocks and aftershocks, elastic rebound theory, seismicity of India, global seismicity, seismic zoning of India, concept of inhomogeneity and anisotropy, types and causes of earthquakes.

Unit II:

Elasticity, Stress-strain relation, Principal and deviatoric stress, Waves on a string, SHM, seismic wave, Snells Law, Fermats Principle, Huygens Principle, Seismic wave equation, Reflection and Transmission coefficients, Introduction to different wave patterns- body, surface and related waves, phase and group velocity, dispersion

Unit III:

Seismic ray theory for spherically stratified earth and velocity structure from travel time data, propagation and characteristics of body waves, surface waves, group and phase velocities, different phases of body waves and their applications, Structural aspects like faulting, fracture and their effects on wave propagation, reflection of body waves, focal mechanism solutions and tectonic implications

Unit IV:

Instruments- Principle of electromagnetic seismograph, displacement meters, velocity meter, WWSSN stations, seismic arrays for detection of nuclear explosions, wide band seismometry, strong motion seismograph. Broad band seismometers and sensors, Short period seismometers and related analysis of seismograms- analog and digital. Seismic data recorders.

GP C 306: Practical based on GP C 303 (2 Credits)

Course Outcome:

- At the end of the course, students will be able to derive fundamental seismological equations from first principles, model earthquake sources using seismic waveforms, model Earth structure with multiple techniques and acquire skills in seismological data acquisition.

Prescribed and Reference Books

1. Fundamentals of Geophysics, William Lowrie
2. An Introduction to Seismology, Earthquakes and Earth structure By Stein & Wysession
3. Engineering Seismology By Agarwal
4. Modem Global Seismology, Thorne Lay and Wallace
5. Internal Constitution of the Earth By Gutenberg
6. Introduction to Seismology by Bath
7. The Earth, Jeffreys.S.H.
8. Elementary Seismology, Charles.F. Richter
9. An introduction to the theory of seismology, Bullen. K.E. and Bolt
10. Quantitative seismology: theory & methods, Aki. K. and Richards
11. Online material

GP E 301: Remote Sensing
Theory: 2 credits & Practical: 1 credit

Pre-requisites:

Basic (10+2) understanding of science

Course objectives:

1. To attain fundamental knowledge of basics of Remote Sensing.
2. To identify different features with the help of Photo-interpretation Elements.
3. To apply Remote Sensing knowledge for different applications in Earth Sciences.

Course content

Unit I: Introduction and Aerial Photography:

Introduction to Remote Sensing, Definition, Characteristics of EMR, Platforms, Fundamentals of Aerial Photography, History of Aerial Photographs, Types of Aerial Photographs- Vertical and Oblique Photographs, Aerial Cameras, Flying Plan, Photogrammetry -- Basic Geometric Characteristics- Scale, Overlap, Tilt, Distortion and Displacement of Aerial Photographs, Advantages and Disadvantages of Aerial Photographs, EMR and its interaction with matter, Reflection, Absorption, Transmission, Scattering. Concept of Signatures- Photo Interpretation Elements.

Unit II: Satellite Remote Sensing and Applications of Remote Sensing:

Principles of Remote Sensing, Process of Remote Sensing, Indian Remote Sensing Programme, Types of Satellites- Sun-synchronous and Geostationary Satellites, Launch Vehicles- PSLV, GSLV, Payloads, Active and Passive Remote Sensing, Classification of Remote Sensors, Resolution- Spatial, Spectral, Radiometric, Temporal, Microwave Sensors, SLAR, Digital Image Processing- Image Classification, Supervised and Unsupervised Classification, Image Enhancement, Filtering, PCA etc.

Applications of Remote Sensing:

Interpretation of Visual and Digital data, Applications in Geology.

GP E 303: Practical based on GP E 301 (1 Credit)

Course outcomes:

At the completion of the course student would be able to

1. Explain the Fundamental principles of Remote Sensing.
2. Explain basic properties of Remote Sensing, Data acquisition, Storage and Processing.
3. Identify different features with the help of Photo interpretation Elements.
4. Apply the knowledge of Remote Sensing for applications in different fields.

Prescribed and Reference Books

- Image Interpretation in Geology by Drury
- Introduction to Remote Sensing by J. B. Campbell
- Photogrammetry by Miller and Miller
- Principles & Applications of Photogeology by S. N. Pande
- Remote Sensing & Image Interpretation by T. M. Lillesand and W. K Ralph
- Remote Sensing in Geology by Siegal
- Remote Sensing: Principles and Interpretation by F. F. Sabins

GP E 302: Geographical Information Systems
Theory: 2 credits & Practical: 1 credit

Pre-requisites: Basic understanding Geology, Geography and Physics (10 / 10+2 level).

Salient features of the Course:

Geographical information system knowledge is very essential to solve various problems and issues in society. It is map-based decision support system and the students will learn about spatial and non-spatial data and mapmaking techniques using GIS softwares. Currently, it is one the most important and job giving sectors for GIS trained persons both in government and private sectors.

Course objectives:

1. Introduce the students to the fundamental concepts of GIS and GPS technologies
2. It will make them familiar with the most essential GIS techniques with hands on practical experience.
3. Students will learn about creation and organization of spatial and non-spatial data.
4. Learn and use different GIS based techniques to identify and solve the natural, environmental and community problems.
5. Learn application of GIS and GPS in geology.

Course content

Unit I:

Introduction to GIS, Definition, History of GIS, Scope and Importance of GIS, Development of GIS, Components of GIS, Data models in GIS - Raster data model, Vector data model, basic entities of GIS: line, point and polygon, Geodatabase, Map Projection, Types and Need of projection system, Spatial and Attribute data, Acquisition of spatial data: Scanning, Georeferencing, concept of layer, digitizing, error detection and correction, DBMS.

Unit II:

Global Positioning Systems, History and developments in GPS, Trilateration process, types of GPS, GPS Surveys, Mapping and layout, Image processing, General processes involved in image processing, mosaic, subset, Point interpolation techniques: Krigging, IDW, Data analysis, network analysis, DEM and DTM, Thematic maps, Geological Applications of GIS and GPS technology

GP E 303: Practical based on GP E 302 (1 Credit)

Course outcomes:

After successful completion of this course, a student should know

1. Differentiate between different data types in GIS.
2. Georeference the spatial data and work on spatial and non-spatial database.
3. Describe various GIS tools and techniques.
4. Explain the fundamental principles behind GPS technology.
5. Visualize GIS outputs in different dimensions.
6. Create digital GIS maps.
7. Apply spatial data analysis for various applications to deal with geological problems.

Prescribed and Reference Books

- An Introduction to Geographical Information Systems by I. Heywood, S. Cornelisus and S. Carver
- Concepts Techniques of Geographical Information Systems by C. P. Lo and A. W. Yeung Geographical Information Systems and Science by P. A. Longley, M. F. Goodchild, D. J. Maguire and D. W. Rhind
- Fundamentals of Geographic Information Systems by M. N. Demers
- Introduction to Geographic Information Systems by K. T. Chang
- Introduction to Global Positioning Systems by Ahmed E. L. Rabbany
- Introductory Digital Image Processing by J. R. Jensen
- Textbook of Remote Sensing and Geographic Information System by M. Anji Reddy
- Principles of Geographical Information Systems by P. A. Burrough and R. A. McDonnell
- The GIS Book by G. B. Korte

GP OE 301 Near Surface Geophysics
Theory: 2 credits

Pre-requisite:

Basic knowledge of geophysics and interest in Earth System Sciences. The students with basic interest to tackle with near surface geological, geotechnical and environmental issues like contaminations, foundations in geotechnical works and groundwater issues. The student who wants to learn the role of geophysics in solving near surface issues is welcome to take this open elective curse.

Course Objective:

This course objective is to introduce the student about the near surface problems, major geophysical methodologies and its role in solving such issues.

Course Content

Unit I:

Introduction to major geophysical methods to be used in near surface investigations Near surface problems and geological setups-in environmental, geotechnical and groundwater studies, physical property characterization, Planning of geophysical surveys, of method data collection and data presentation and qualitative understanding and interpretation of geophysical data.

Unit II:

Environmental geophysics-pollution detection, landfill characterization; Groundwater geophysics-location of water in shallow aquifers, salinity problems in coastal aquifers:
Engineering Geophysics: Testing of foundations, location of underground pipelines, soil studies; Applications and discussion of some case studies

Course Outcome:

At the end of the course the student will get knowledge about role of geophysics and its importance in solving near surface geological and environmental issues of societal interest.

Prescribed and Reference Books

1. Outlines of Geophysical Prospecting - A manual for geologists by Ramachandra Rao, M.B., Prasaranga, University of Mysore, Mysore, 1975.
2. Exploration Geophysics - An Outline by Bhimasarikaram V.L.S., Association of Exploration Geophysicists, Osmania University, Hyderabad, 1990.
3. Engineering and Environmental Geophysics, Lecture notes by Norbert Péter Szabó University of Miskolc
4. Online material

Program: M. Sc. Geophysics- Course Structure Under Choice Based Credit System (CBCS): Program Code: SES-S-GP-PG (14-2-5-01)

School of Earth Sciences, SRTM University

M. Sc. Second Year (Semester IV) to be implemented from 2020-21

S.N	Course	Code	Course title	Credits
1	Core	GP C 401	Well Logging	4
2	Core	GP C 402	Seismic prospecting	4
3	Core	GP C 403	Dissertation	4
4	Discipline specific Elective (DSE) course for subject/School student (choose any one)	GP E 401	Electro Magnetic Methods	3
		GP E 402	Climatology	
5	Generic Elective Course (Open Elective) (GEC) to be selected by the student from other Schools in University	GP OE 401	Understanding Seismograms	2
	Total Theory credits			17

Practical IV Semester M.Sc. Geophysics

S.N	Course	Code	Course title	Credits
1	Core	GP C 404	Well Logging	2
2	Core	GP C 405	Seismic prospecting	2
3	Core	GP C 406	Dissertation Viva	2
4	Discipline specific Elective (DSE) course for subject/School student (choose any one)	GP E 403	Electro Magnetic Methods	1
		GP E 404	Climatology	
5	Core	GP C 407	Seminar/Field Report	1
	Total Practical credits			8
Total Credits (Theory & Practical)				25

GP C 401 Well logging
(Theory: 4 credits & Practical: 2 credits)

Pre-requisites:

- Basic of physical properties of electricity, magnetism, sound, radio activity, of different materials

Course Objective:

- The main objectives of the course are to introduce the students to the fundamental concepts of well logging and its interpretation. To provide solid knowledge to read well logs, apply the necessary environmental corrections, and perform well log interpretations to hydrocarbon bearing formations and communicate the results effectively.

Course Content

Unit I:

Introduction: Drilling of a Well. Drilling Fluids. Mud Filtrates, Invasion Profile Logging Unit. Depth Control. Well Pressures, Bore Hole Environment, Formation Factor. Porosity & Water saturations, Occurrences of Hydrocarbons, Minerals and Water, Tool design and Tool Principles.

Unit II:

Electrical logging: S.P Log: Origin, Static SP, Shale Base Line, SP in various aquifers, Determination of Rw, Conventional Resistivity Logs; Normal, Lateral Curves, Focused Logs: Latero Log - 3. Latero Log-7, DLL, SFL and Comparative study, Induction Log: DIL, HRI-High Resolution Induction Log. Micro Log, Micro & Micro Latero Log, Micro SFL. Determination of Rmf, Rxo & Rt. Dip meter. Side Wall Coring, Logging for Ground Water, Coal & Minerals

Unit III:

Radioactive Logs: Principles of Radioactivity, Counters, Gamma Ray Log Statistical Variations, Neutron - Gamma,, Neutron - Neutron Logs, Thermal Decay logs, Density Log, Identification of Lithology, & Porosity. CMR Log: and identification of free fluids. MDT and introduction PLT survey. Sonic Logs: Transit Time, Sonic Velocities, Sonic Porosities Cementation. Cased Hole Logs- . Identification of Water, Minerals and Hydrocarbons and fractures.

Unit IV:

Interpretation of Log data: Lithology & Porosity determination from cross plots. Permeability determination, M-N Plots. Common Sedimentary rocks. Clean and Shaly formations, Cross Plots Techniques, Quick look interpretation and detailed interpretation of Clean sands and Shaly sands, Water Saturation. Identification of Hydrocarbon zones, Mineral Zones, water Zones and Coal.

GP C 404: Practical based on GP C 401 (2 Credits)

Course Outcome:

- After completion of the course students are expected to acquire knowledge in various well logging tools and its interpretation. These skills are useful in Oil exploration and resource evaluations.

Prescribed and Reference Books

1. Formation Evaluation, E J Lynch
2. Induction Logging, Plusynin.
3. Log Interpretation Principles and Charts, Schlumberger
4. Schlumberger Documents,
5. Development and Exploitation of Oils and Gas Fields, Murovyer and Andiasevrentnal
6. Handbook of Well Log Analysis, S J Peterson.
7. Online material

GP C 402 Seismic Prospecting
Theory: 4 credits & Practical: 2 credits

Pre-requisites:

- Basic Physical concepts of elastic properties of different materials, structures within the upper crust of the earth

Course Objective:

- The objective is to train the student in the seismic prospecting methods using reflection and refraction techniques. The course is to provide knowledge about artificial seismic energy generation techniques, seismic wave propagation and seismic reflection/refraction prospecting methodologies. The course also aims at data acquisition, data processing, and analysis and interpretation techniques associated with different seismic prospecting methods.

The same course will be offered to the students of M.Sc Physics program as an Elective

Course Content

Unit I:

Introduction to seismic prospecting, elasticity principles: Normal strains, shearing strains, Hook's law, Elastic moduli, wave equations, Huygen's & Fermat's Principles, wave characteristics-refraction, reflection, diffraction, attenuation & absorption of seismic waves, acoustic impedance, reflection and transmission coefficients. Elastic wave velocities of rocks: velocity inversion, low velocity layer, blind zone, hidden layer.

Unit II:

Electromagnetic geophone and its performance, damping coefficient, hydrophones, analog data acquisition, amplifiers, filters, gain control and recording types. Seismic energy sources for land and marine surveys. Dynamite thumper, vibrosies, land air gun, pinger, boomer, sparker, airgun, water gun. Controlled explosions, shot control, source arrays, energy content, frequency, pulse length and resolution, penetration, signatures of energy sources. Digital data acquisition

Unit III:

Seismic Refraction surveys: Field procedures, fan shooting, broad side shooting, inline profiling, long refraction profiles, reversed and unreversed profiles, marine refraction surveys, sonobuoy surveys. Reduction of refraction data, interpretation of refraction data, analysis of refraction records, interpretation of reversed and unreversed profiles, delay time methods, forward modeling, masked

layers and hidden layers, crustal seismology, engineering surveys, exploration for ground water, application in mining industry.

Unit IV:

Seismic Reflection surveys: Field procedures, Reflection data processing, static and dynamic corrections, velocity determination. Preparation of seismic sections migration, analysis of analog records, automatic processing of digital seismic data, different methods of migration, Geological interpretation: application of reflection method, exploration for oil and gas, groundwater, coal, mineral deposits, gas hydrates, etc., engineering applications, crustal studies, structural and stratigraphic traps, identification of geological structures like anticlines, faults, salt domes etc;

GP C 405: Practical based on GP C 402 (2 Credits)

Course Outcome:

- At the end of the course, students will acquire all the necessary knowledge in seismic prospecting. This knowledge will be useful in oil exploration programs and mineral exploration programs. .

Prescribed and Reference Books

1. Introduction to geophysical exploration, Keary Brooks
2. Introduction to geophysical prospecting, M.B.Dobrin.
3. Applied Geophysics, W.M. Telford et. al.
4. Exploration seismology, Sheriff. R.E.
5. Seismic stratigraphy-application to hydrocarbon exploration Ed. By Charles Payton.
6. Shear wave exploration, SH Danbom and SN Domenico
7. Multicomponent seismology in petroleum exploration, RH Tathamz and MD McCormack
8. Fundamentals of seismic tomography, Lo and Inderweisen
9. Reservoir studies, SEG publication.
10. Seismic exploration fundamentals, J.A. Coffeen.
11. A hand book for seismic data acquisition, Brain J Evans
12. Online material

GP C 403: Dissertation
Thesis: 4 credits & Presentation: 2 credits

Pre-requisites:

Completed all required credits of Theory and Practical.

Course objectives:

1. To independently work on a scientific problem.
2. To able to generate new data OR able to synthesize and analyze available large global data sets.
3. To interpret the data and derive scientifically robust conclusions.
4. To learn software required for thesis work.
5. To develop the writing skills based on research pattern/report writing which is useful in research institutes / govt. organizations / Pvt. organizations.
6. To develop the analytical and interpretative skills so that he/she will be competent enough to get job in this field of specialization.

Thesis (4 Credits):

Every Post-graduate student has to mandatorily submit dissertation thesis. The dissertation work is based on either new data generated for the proposed scientific problem OR based on available large global data sets using innovative ideas. The thesis should be based on sound methodology and well defined objectives.

GP C 406: Presentation based on GP C 403 (2 Credits)

Course outcomes:

At the completion of the course students would be able to

1. Well versed with the literature on the chosen topic.
2. Independently define a scientific problem.
3. Carry out focused study on a research topic.
4. Analyze and interpret large data sets.
5. Independently write thesis / project proposal.
6. Present and defend the scientific work.

Every student has to present his/her thesis in open house and defend their work.

GP E 401 Electromagnetic Methods
Theory: 3 credits & Practical: 1 credit

Pre-requisites

- Basic Physical concepts of electromgnetism, Maxwell's equations, conductivity and magnetic properties of Earth materials

Course Objective:

- The objective is to train the student in the electromagnetic methods using both natural and artificial sources. The course is to provide knowledge about various methods using electromagnetic principle. The course also aims at data acquisition, data processing, and analysis and interpretation techniques associated with different Electromagnetic prospecting methods.

Course Content

Unit I:

Basic concept of Electromagnetic induction, Maxwell's equations, plane wave characteristics, wave number, impedance, skin depth; primary-secondary field relations, elliptic polarization, real and imaginary components, response function. Methods of measurement for different source-receiver configurations. Components in EM measurements. Introduction to natural source EM methods.

Unit II:

Artificial source methods, classification frequency domain EM, Turam, VLEM and Slingram methods, principles, field procedures, quantitative interpretation; time domain EM, general field procedures, interpretation of surface transient method data.

Unit III:

EM sounding, geometric and parametric soundings, field procedures, interpretation; VLF; ground penetrating radar. Airborne EM methods, passive airborne EM systems, AFMAG and VLF; application of EM Methods in mineral and ground water exploration, geological mapping and engineering problems.

GP E 403: Practical based on GP E 401 (1 Credits)

Course Outcome:

- At the end of the course, students will acquire all the necessary knowledge in electromagnetic methods used in the exploration. This knowledge will be useful in mineral exploration programs and geological Mapping. .

Prescribed and Reference Books

1. Applied Geophysics, Telford, et. al., revised edition
2. Electrical methods of Geophysical Prospecting, Keller and Frischknecht
3. Mining Geophysics, Parasnis
4. Philip Kearey and Michael Brooks, An introduction to geophysical exploration, 2000, Blackwell Science.
5. Outline of Geophysical Prospecting, M.B. Ramchandra Rao.
6. Field Geophysics, John Milsom
7. Online material

GP E 402: Climatology
Theory: 3 credits & Practical: 1 credit

Pre-requisites:

Student should have the basic idea about atmosphere, oceanography, understanding of geological processes which are directly or indirectly related to atmospheric processes.

Course objectives:

1. Introducing students to climate sciences.
2. To enable students to correlate atmosphere-ocean-land processes.
3. To understand the effect and impact of climate phenomenon on life, land and on oceanic processes.
4. Cosmic, Geological and anthropogenic controls on long-term and short-tern climates

Course content

Unit I:

Introduction to climatic geology, atmosphere, lithosphere; Fundamental principles of climatology. Earth's radiation balance; latitudinal and seasonal variation of insolation, temperature, pressure, wind belts, humidity, cloud formation and precipitation, water balance. Air masses, monsoon, Jet streams, tropical cyclones, and ENSO.

Unit II:

Climatic and sea level changes on different time scales. General weather systems of India - Monsoon system, cyclone and jet stream, Western disturbances and severe local convective systems, distribution of precipitation over India.
Classification of climates – Koppen's and Thornthwaite's scheme of classification. Climate change.

Unit III:

Ocean dynamics; paleo-climate; geo-biology; Antarctica and study of ice sheets global warming, atmospheric aerosols and air pollution, ozone deflation, framework of climate change, Milankovitch cycles and solar activity, climate modeling.

GP E 404: Practical based on GEO-E402 (1 Credit)

Course outcomes:

At the completion of the course student would be able to

1. Understand Climate geology and their products.
2. Comprehend interaction between geology-climatology-oceanography.
3. Correlation of geological, climatic and oceanic processes.
4. Understand the direct and/or indirect impact of anthrop on climatic processes.

Prescribed and Reference Books

- **Advances in Climatology** by **Dale Sullivan**
- **Applied Climatology Principles and Practice** by **Allen Perry, Dr Russell Thompson, Russell Thompson**
- **Climatology** by **Anthony J. Vega and Robert V. Rohli**
- **Climatology** by **D.S. Lal**
- **Climatology Concepts and Applications** by **Dale Sullivan**
- **Climatology New Developments** by **Adam Herveoux, Eric Suthland**
- **Climatology: An Atmospheric Science** by **J.E. Oliver and J.J. Hidore**
- **Encyclopedia of World Climatology (Springer series)**
- **General climatology** by **Howard J. Critchfield**
- **Glaciers and climate change** by **J. Oerlemans**
- **Global physical climatology** by **Dennis L. Hartmann**
- **Global Warming** by **John Houghton**
- **Global Warming Myth or Reality?: The Erring Ways of Climatology** by **Marcel Leroux**
- **Inconvenient Truth The Planetary Emergency of Global Warming and What We Can Do About It** by **Al Gore**
- **Meteorology Today: An Introduction to Weather, Climate and the Environment** by **C.D. Ahrens**
- **Principles of Climatology** by **Salem Press**
- **The Earth System** by **L.R. Kump J.F. Kasting and R.G. Crane**
- **Understanding Climatology** by **Salvador Poole**

GP OE 401 Understanding Seismograms
Theory: 2 Credits

Pre-requisites:

Interest in study of the Earthquakes, basics high school mathematics and physics with knowledge of logarithms

Course Objectives:

The objective of this course is to introduce basics of interpreting seismograms.

Course Content

Unit I:

Earth structure and various earthquake phases of seismic waves, Local earth quakes, regional earthquakes, teleseismic earthquakes and its seismograms

Unit II:

Seismometers and types of it, Earthquake intensity, seismic zoning of India, using seismograms interpreting the epicentral distance and magnitude, how to check the earthquake location and magnitude from online catalogues

Course Outcomes:

At the end of the course the students will gain basic understanding of seismograms,
Will be able to identify different phases and compute magnitude.

Prescribed and Reference Books

1. Earthquakes: N Purnachandra Rao, APAS
2. The Earth: Press and Seiver
3. Fundamentals of Geophysics: William Lowrie
4. Anatomy of seismograms: Ota Kulhanek
5. An Introduction to Seismology, Earthquakes and Earth structure: Stein & Wysession
6. Microearthquake Seismology and Seismotectonics of South Asia L J R Kayal
7. USGS web portal
8. NCS Web portal
9. Online material