Mizoram University
School of Physical Sciences
Aizawl- 796004

INTERDISCIPLINARY COURSE
ON
GEOPHYSICS

2nd Revised
2 Years M.Sc. (GeoPhysics) Course
under
Multiple Entry and Exit (MEE-NEP 2020)

December 2021
(w.e.f. Academic session 2022-23)

A. Structure of 2-Year MEE M. Sc. (Geophysics) Course

Course No.	Name of paper	Mark scale	Credit	Page No.
1st SEMESTER				
GP/MJ/500	Geomathematics	100	**3**	6
GP/MJ/501	Geophysical Prospecting	100	**3**	8
GP/MJ/502	Well Logging	100	**3**	10
IMJ	Course from other department	100	**3**	11
GP/MN/503	Numerical Techniques	100	**2**	12
IMN	Course from other department	100	**2**	13
GP/FP/504	Laboratory-1	100	**4**	14
		700	**20**	
2nd SEMESTER				
GP/MJ/550	Theory of fields	100	**3**	15
GP/MJ/551	Basin Analysis & Petroleum Geology	100	**3**	16
GP/MJ/552	Near Surface Geophysics & Geotechnical Modelling	100	**3**	17
IMJ	Course from other department	100	**3**	18
GP/MN/553	Basic Electronics	100	**2**	19
IMN	Course from other department	100	**2**	20
GP/FP/554	Laboratory-2	100	**4**	21
	Total	**700**	**20**	
3rd SEMESTER				
GP/MJ/600-A GP/MJ/600-B	a) Seismology b) Remote Sensing & GIS	100	**3**	22 24
GP/MJ/601-A GP/MJ/601-B	a) Solid Earth Geophysics b) Mining Geology	100	**3**	26 27
GP/MN/602	Environmental Physics	100	**2**	29
IMN	Course from other department	100	**2**	30
GP/FP/603	Laboratory-3	100	**4**	31
GP/MJ/649	Project Work	100	**6**	32
		600	**20**	
4th SEMESTER				
GP/MJ/650	Oceanography and Climatology	100	**4**	33
GP/FP/651	Laboratory-4	100	**4**	34
GP/MJ/699	Dissertation	100	**12**	35
	Total	**300**	**20**	
	Grand Total:	**2300**	**80**	

DMj= Disciplinary Major, IMj= Interdisciplinary Major, DMn = Disciplinary Minor,
IMn= Interdisciplinary Minor, FP= Field Works, RP=Research Project/Dissertation

Detailed Course Structure of 2-Year MEE M.Sc. (Geophysics) Syllabus

Course no.	Course title	Course Credit	Mark scale			Credit distribution			Exam (Hrs.)	
			C/A	Ext	Total	L	T	P	T	P
1st SEMESTER										
GP/MJ/500	Geomathematics	**3**	40	60	100	2	1	0	3	-
GP/MJ/501	Geophysical Prospecting	**3**	40	60	100	2	1	0	3	-
GP/MJ/502	Well Logging	**3**	40	60	100	2	1	0	3	
IMJ	Course from other department	**3**	40	60	100	2	1	0	3	-
GP/MN/503	Numerical Techniques	**2**	40	60	100	2	0	0	2	-
IMN	Course from other department	**2**	40	60	100	2	0	0	2	-
GP/FP/504	Lab-1	**4**	40	60	100	0	0	4	-	3
	Total	**20**			**700**	**12**	**4**	**4**		
2nd SEMESTER										
GP/MJ/550	Theory of Fields	**3**	40	60	100	2	1	0	3	-
GP/MJ/551	Basin Analysis & Petroleum Geology	**3**	40	60	100	2	1	0	3	-
GP/MJ/552	Near surface Geophysics & Geotechnical Modelling	**3**	40	60	100	2	1	0	3	-
IMJ	Course from other department	**3**	40	60	100	2	1	0	3	-
GP/MN/553	Basic Electronics	**2**	40	60	100	2	0	0	2	-
IMN	Course from other department	**2**	40	60	100	2	0	0	2	-
GP/FP/554	Lab-3	**4**	40	60	100	0	0	4	-	3
	Total	**20**			**700**	**12**	**4**	**4**		
3rd SEMESTER										
GP/MJ/600-A GP/MJ/600-B	Seismology Remote sensing & GIS	**3**	40	60	100	2	1	0	3	-
GP/MJ/601-A GP/MJ/601-B	Solid Earth Geophysics Mining Geology	**3**	40	60	100	2	1	0	3	-
GP/MN/602	Environmental Physics	**2**	40	60	100	2	0	0	2	-
IMN	Course from other department	**2**	40	60	100	2	0	0	2	-
GP/FP/603	Laboratory-3	**4**	40	60	100	0	0	4	-	3
GP/MJ/649	Project Work	**6**	40	60	100	0	0	6	-	-
	Total	**20**			**600**	**8**	**2**	**10**		
4th SEMESTER										
GP/MJ/650	Oceanography and Climatology	**4**	40	60	100	3	1	0	3	-
GP/FP/651	Laboratory-4	**4**	40	60	100	0	0	4	-	-
GP/MJ/699	Dissertation	**12**	40	60	100	0	0	12	-	-
	Total	**20**			**300**	**3**	**1**	**16**	-	-
	Grand Total	**80**			**2200**	**46**		**34**		

Note: 1. L = Lecture, T = Tutorial, P = Practical

2. DMj/IMj = **34** Credits, DMn/IMn = **12** Credits, FP = **16** Credits, RP = **18** Credits

3. Theory = **46** Credits, Practical & Field Work = **16** Credits, Dissertation = **18** Credits

B. Provisions for Multiple Entry and Exit in Academic Progammes offered in Mizoram University

Keeping in mind the flexibility of learning under the NEP 2020, provisions are made for multiple entry and exit for students so they will have options. The entry or re-entry of students from the University or other HEIs is allowed at the odd semester and the exit will be allowed after the even semester. The requirements for entry and exit are as follows:

Master's Degree Programme (Level 9)

There shall be two main types of Master's Degree Programmes (Level 9) under Mizoram University such as:

i) A two-year (four semester) Master's Degree Programme and

ii) A one-year (two semester) Master's Degree Programme

Besides these, there may be an integrated five-year Bachelor's/Master's Programme.

Two-Year (Four-Semester) Master's Degree Programme (Level 9)

Entry: On completion of a three-year Bachelor's Programme (Level 7), a student shall be eligible for entry into a Two-Year (Four-Semester) Master's Degree Programme (Level 9) with the second year devoted entirely to research.

Exit: A student who desires to exit after successful completion of one year (2 semesters) of Master's Degree Programme equivalent to 40 credits shall be awarded **Post-Graduate Diploma (Level 8)**. A student who successfully completes the two-year Master's Degree Programme equivalent to 80 credits shall be awarded **Master's Degree (Level 9)**.

One-Year (Two-Semester) Master's Degree Programme (Level 9)

Entry: Entry into a One-Year (Two-Semester) Master's Degree Programme (Level 9) shall be for those students who obtained a Bachelor's Degree (Honours/Research) that is, Level 8).

Exit: A student, on completion of the One-Year (Two-Semester) Master's Degree Programme (level 9) equivalent to 40 credits shall be awarded a **Master's Degree**.

Exit Program for M.Sc (GeoPhysics) Course

Sl. No.	Level	Qualification	Credit
1.	Level 8	Post-Graduate Diploma (For those who exit after completion of 1 Year or 2 Semesters of 2-Year Master Degree Programme)	40
2.	Level 9	Master's Degree (2 Years or 4 Semesters after a 3-Year Bachelor's degree)	80
3.	Level 9	Master's Degree (1 Year or 2 Semesters after a 4-Year Bachelor's Degree with Honours/Research)	40

C. Format for Recording of Practical Course Works

(A) Disciplinary Major Course Practical Work

Experiment No:
Commencement and Completion Dates:
Aim of the Experiment: Apparatus:
Theory: The theory part may consist of the following

- Brief explanation of the effect, law, phenomena, circuit, etc under study and related formulae and equations involved
- Principle of the experiments
- Supporting figures with figure captions

Procedures: Step by step instructions to set up the apparatus, take measurements and calculate the results.
Observation: Data recorded in experiment should be presented in form of table systematically.
Calculation: Calculation may consist of calculation using the formula or from graph and error analysis.
Conclusion: Brief summary of the experiment leading to the results obtained.
Precautions: Precautions related to errors minimization, personal safety, protection to the instrument, warnings, etc.

(B) Specialization Courses (Disciplinary Major) Practical Work

Experiment No:
Commencement and Completion Dates:
Title of the Experiment:
Introduction: Background of the effect, process, law, phenomenon, etc, under study and importance of the experiment going to perform.
Theory: The theory part may consist of the following

- Brief explanation of the effect, law, phenomena, circuit, etc under study and related formulae and equations involved.
- Principle of the experiment
- Supporting figures with figure captions

Methods:

- Brief description of the instrument, devices, samples, etc. used
- Environmental conditions (if necessary)
- Procedures
- Precautions

Results:

- Systematic presentation of experimental data.
- Calculation of results and error analysis
- Graphs or any other graphical representations of the data, result, etc.

Discussion: Interpretation of the results
Conclusion: Brief summary of the experiment and future scope

First Semester

GEOMATHEMATICS

Course No.: GP/MJ/500

Marks Scale: 100 marks (End Sem. Exam: 60+ Internal: 40)

Credit: 3 (2- 1- 0)

Course Outcome/Learning Outcome: This module will enable the student to gain fundamental knowledge of various mathematical functions and equations which are useful in the study of geophysics. The course aims at arming the students with necessary mathematical tools used in analyzing geophysical problems.

Unit -1: Vector Spaces and Matrices

Linear dependence and independence of vectors, Inner product, Schmidt's orthogonalization method. Matrices– transpose, symmetric & skew-symmetric, 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 2: Special functions

Legendre equation: Rodrigue formula for $P_n(x)$, generation function and recurrence relation, Associated Legendre polynomial. Bessel equation: Bessel function, generating functions and recurrence relation. Hermite Equation: generating function and recurrence relation. Laguerre equation: generating function, recurrence relation, Rodrigue formula, Associated Laguerre polynomials.

Unit 3: Transforms

Fourier Transforms: Finite Fourier Transforms, Fourier sine and cosine transform, properties of a Fourier transform, derivative of a transform, transform of the derivative, Inverse Fourier transform and its properties, application of Fourier transforms to boundary value problems.

Laplace transform: Definition, properties of Laplace transforms, Laplace transforms of some special functions, evaluation of integrals with Laplace transforms, Inverse Laplace transform, properties. Application of Laplace transform. Dirac delta function- properties and simple problems.

Unit 4: Complex Analysis

Complex function: continuity, derivative, analytic functions, harmonic functions, Cauchy-Riemann condition for analytic functions. Taylor and Laurent series. Zeros and Singularities of an analytical function (isolated, removable and essential singularity), Calculus of residues. Complex integration: Cauchy's theorem, Cauchy's integral formula and Applications.

Recommended Books:

1. A W Joshi, 2005: *Matrices and Tensors in Physics*, New Age International.
2. G B Arfken and H J Weber, 2005: *Mathematical Methods for Physicists*, Academic Press, 6th Ed.
3. S Chandra, 2003: *A Textbook of Mathematical Physics*, Narosa Pub. House.
4. H K Das, 2010: *A Textbook of Mathematical Physics*, S. Chand & Co. Ltd. (2010).
5. S Gurung and L Sailo, 2020: *A Handbook of Mathematical Physics*, PUC and GSC joint publication.

Additional readings:

1. Riley K F, 2002: *Mathematical Methods for Physics and Engineering*, Cambridge University Press.
2. Murray R Spiegel, 2017: *Complex Variables*, Mc Graw Hill (Schaum's Series), 2nd Edition.
3. B Rai, D P Choudhury and H I Freedman, 2002: *A Course in Ordinary Differential Equations*, Narosa Pub. House
4. Charlie Harper, 2009: *Introduction to Mathematical Physics*, PHI, New Delhi.

First Semester

GEOPHYSICAL PROSPECTING

Course No.: GP/MJ/501

Marks scale: 100 marks (End Sem. Exam: 60+Internal: 40)

Credit: 3 (2- 1- 0)

Course Outcome/Learning Outcome: The primary goal of this course is to provide basic understanding of different geophysical methods. The students will learn the fundamental and advance aspects of seismic data acquisition technique to study the subsurface geology, introduce gravity methods and their application for geological prospect such as identification of fault, fracture, joints, syncline/anticline etc. and classification of rocks, mineral, non-minerals. Further, the course aims to familiarize students with resistivity method which is used extensively in hydrogeological, environmental and geotechnical aspects of civil engineering, engineering geology and in mining engineering problems. The ultimate goal of the course is to solve geological problems by understanding the concepts of physics using different geophysical signature.

UNIT– I: Gravity method

Basic for gravity exploration, concept of geoid, international gravity formula, unit of gravity. Gravimeters: Spring-mass system as basic gravimeters, principles of working of unstable gravimeters, zero length spring, La-Coste- Romberg and Worden gravimeters. Drift. correction. Gravity effect due to buried sphere. Densities of common rocks and minerals. Filter theory and filtering of potential field data, Gravity anomalies over spheres, cylinders, dykes, faults and sheets

UNIT- II: Magnetic method

Magnetic susceptibility of rocks and their ranges, elements of earth magnetic field; Magnetometers: Fluxgate and Proton Precession Magnetometers, Diurnal Correction; Magnetic effect due to isolated pole. Susceptibilities and densities of various rocks and minerals, factors affecting density and susceptibilities, density and susceptibility determination. Magnetic prospecting instruments: flux gate, proton precession and Rubidium vapour magnetometers. Magnetic anomalies over single pole, dipole, line pole, spheres, cylinders, faults and dykes, graticules and anomalies of irregular bodies

UNIT- III: Seismic Exploration

Historical Development and Background of Refraction and Reflection Methods, Difference between Refraction and Reflection Surveys, Propagation of Seismic Waves in Linear and Nonlinear medium, N-Layered case, continuous increase of velocity. Waveforms and their characteristics, Elastic wave velocities in rocks, Principles of Geometrical Optics, generation and propagation of seismic waves, seismic energy sources, geometry of refraction and reflection, interpretation of travel time curves for two layered earth· horizontal and dipping interface, field procedure-profile and broad side shooting, fan shooting, end on and split spread arrangements. Basics of Seismic data Acquisition systems, Explosive and Non-Explosive sources, seismic operation on Land and sea, Grouping of Geophones and shot points.

UNIT- IV: Resistivity Method

Basic Principles of electrical methods of prospecting. Classification of methods. Electrical properties of rocks and minerals; Influence of (1) mineral composition (2) moisture and salinity (3) Temperature on resistivity. Resistivities of common rocks and minerals, True and apparent resistivity, Electrode configurations- Schlumberger and Wenner, Electrical profiling Vertical Electrical Sounding, Interpretation of two layered VES curves.

Recommended Books:

1. Dobrin M.B. & Savit C.H. (1988): Introduction to Geophysical Prospecting. Mc. Graw Hill Book Company, Singapore.
2. Telford, W.M., Geldart, L.P. Sheriff, R.E. & Keys, D.A. (1981): Applied Geophysics, Cambridge University Press, Cambridge.
3. Sheriff, R.E. & Geldart, L.P. (1987): Exploration Seismology, Vol. I, Cambridge Univ. Press, Cambridge.
4. Sheriff, R.E. & Geldart, L.P. (1987): Exploration Seismology, Vol. II, Cambridge Univ. Press, Cambridge.
5. Anstey N.A. (1971): Seismic Prospecting Instruments Vol, II. Gebrudev Borntraege Stuttgart.
6. Evenden, B.S. & Stone, D.R. (1971): Seismic Prospecting Instruments, Gebrudev Borntraege, Berlin, Stuttgart.
7. Sheriff R.E. (1989): Geophysical Methods, prentice Hall, Englewood cliffs, NewJersey.
8. Balch A. & Lee M.W (1984): Vertical Seismic Profiling. Technique, Applicationsand case histories, D. Reidal Publishing Company, Boston, USA.
9. Robinson E.A. (1988): Migration of Seismic data SEG Publication.
10. Verma R.K. (1986): Offshore Seismic Exploration Gulf Publishing Co.

Additional readings:

1. Yilmaz O. (1987): Seismic Data Processing, SEG Publication
2. Parkhomenko E.I. (1967): Electrical Properties of Rocks – Plenum Press, New York.
3. Keller & Frischkeicht (1966): Electrical methods in Geophysical ProspectingPergaon.
4. Telford W.N., Geldart, Sheriff L.P., R.F. & Keys D.A. (1985): Applied Geophysics, Cambridge University Press.
5. Stanislav Mares (1984): Introduction to Applied Geophysics, D.Reidel Publishing.
6. D.S.Parasnis (1977: Introduction to Apllied Geophysics, Published by Chapman & Hall, London.
7. Patra & Bhattacharya (1969): Direct Current Geoelectrical Sounding, Elsevier.
8. Koefeed C (1980): Principles of Geoelectrical Soundings, Elsevier.
9. Ward S.H. (1969): Mining Geophysics, SEG.

First Semester

Well Logging

Course No: *GP/MJ/502*

Marks Scale: 100 marks (End Sem.Exam:60+Internal :40)

Credit : 3 (2- 1- 0)

Learning Objectives: Knowledge on Well Logging Tool. Knowledge on borehole Corrections. Knowledge on Perforation and Cased-hole tools

Course Goal / Learning Outcome: The primary objective of the course is to introduce Well logging Techniques for Hydrocarbon and groundwater exploration.

Unit -1

Introduction and basic concept to well logging and borehole environment. Drilling fluids/muds, Borehole environment, Invasion profiles. Rock composition and water saturation Profile with lateral distance for Oil wet and Water wet rock.

Unit-II

Principles, methods and application of logging tools including Spontaneous polarization, Resistivity Resistivity Tools (Normal, Lateral, Laterolog, Dual Latero log and Dual Induction log), Microresistivity, Induction, Sonic, Density, Litho-density, Neutron, Pulsed neutron, Natural Gamma ray, Gamma ray spectrometry, Cement bond, Variable density, Caliper, Dipmeter (Dipmeter Logging Tool), Formation microscanner and imager.

Unit-III

Formation evaluation, Archie's Law Well log interpretations. Well planning. Geo-Technical Order. Drilling method. Drilling rigs Rig operating systems. Drilling fluids function and properties. Drilling fluid maintenance equipment. Oil & gas well cementing operations.

Unit-IV

Drill bit types and their applications. Drill string & Casing string function, operations, selection & design. Drilling problems, their control & remedies. Directional drilling tools. Directional survey. Application of horizontal, multilateral, extended reach, slim wells. Functions of casing – Types of casing – Casing properties Casing specifications.

Recommended Books

1. Bateman, R, M., Open Hole Log Analysis and Formation Evaluation.
2. Bateman, R, M., Cased Hole Log Analysis and Reservoir Performance Monitoring.

Reference Books

1. Brock, J., Open Hole Log Analysis
2. Ellis, D. V., Well Logging for Earth Scientists
3. Helander, D. P., Fundamentals of Formation Evaluation.
4. Serra, O., Fundamentals of Well Log Interpretation
5. Vaish, J. P., Geophysical Well Logging: Principles and Practices

First Semester

Numerical Methods
Course No.: AMS/MJ/500

Marks scale: 100 marks (End Sem. Exam: 60+Internal: 40)

Credit: 3 (2- 1- 0)

Course from Other Departments

First Semester

NUMERICAL TECHNIQUES

Course No.: GP/MN/503

Marks scale: 100 marks (End Sem. Exam: 60+Internal: 40)

Credit: 2 (2- 0- 0)

Course Outcome/Learning Outcome: The course aims at making the students aware of the various Numerical techniques. On completion of the course, the students are expected to be able to solve Integration, Differentiation, problems on matrices and curve fitting etc.

Unit I:

The Principle of Least squares, fitting a straight line, fitting a parabola, fitting an exponential curve, fitting curve of the form y=axb, 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. Newton cotes formula, trapezoidal rule, Simpson's one third rule, Simpson's three eight rule, Gauss quadratics method, Monte Carlo method:

Unit II:

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. Computation of real eigenvalues and corresponding eigenvectors of a symmetricmatrix, power method and inverse power method. Solution of differential equation: Taylor series method, Euler method, Runge Kutta method, predictor- corrector method. Partial differential equations: Difference equation method over a rectangular domain for solving elliptic, parabolic and hyperbolic partial differential equation.

Recommended Books:

1. H M Antia, 2012: *Numerical methods for scientists and engineers*, Hindustan Book Agency.
2. W H Press, B P Flannery, W T Vetterling and S Teukolsky, 2007: *Numerical Recipes, Cambridge University Press, 3rd Edition.*
3. S S Sastry, 2005: *Introductory method of numerical analysis*, PHI, 4th Edition.
4. V Rajaraman, 1993: *Computer Oriented Numerical Methods*, PHI, 3rd Edition.
5. P B Patil and U P Verma, 2009: *Numerical Computational methods*, Alpha Science International Ltd., Revised Edition.
6. M K Jain, S R K Iyengar and R K Jain, 2012: *Numerical methods: for scientific and engineering computation*, New Age International, 6th edition.
7. Erwin Kreyszig,2010: *Advanced engineering mathematics*, Wiley, 10th Edition.
8. E Balagurusamy, 2019: *Programming in ANSI C*, McGraw-Hill, 8th Edition.
9. Y Kanetkar, 2016: *Let us C*, BPB Publications, 15th Edition.
10. Suresh Chandra, 2014: *Computer application in Physics*, Alpha Science International Ltd., 3rd Edition.

First Semester

Research Methodology and Statistical Computing

Course No.: AMS/MN/503

Marks scale: 100 marks (End Sem. Exam: 60+Internal: 40)

Credit: 2 (2- 0- 0)

Course from other Departments

First Semester

LABORATORY-1

Course No: *GP/FP/504*

Marks Scale: 100 marks (End Sem.Exam:60+Internal :40)

Credit : 4 (0-0-4)

Students shall perform Practical and Field works based on the following Experiments.

1. Construction of travel time curves of direct and refracted waves (Horizontal layer)
2. Construction of travel time curves of direct and refracted waves (Dipping layer)
3. Construction of travel time curves of reflected waves. (Horizontal layer).
4. Construction of travel time curves of reflected waves (Dipping layer).
5. Processing and interpretation of given refraction seismograms.
6. Processing and interpretation of given reflection seismograms.
7. Interpretation of VES curves for two layered earth and three-layered earth.
8. Calculation of water saturation from SP, Resistivity and porosity logs.
9. Lithology identification from gamma ray and Resistivity logs.
10. Interpretations on Spontaneous polarization, Resistivity, Micro resistivity, Induction, Sonic, Density, Litho-density, Neutron, Pulsed neutron, Natural Gamma ray, Gamma ray spectrometry, Cement bond, Variable density, Caliper and Dip meter logs. Preparation of GTO.

Second Semester

THEORY OF FIELDS

Course No.: GP/MJ/550

Marks Scale: 100 marks (End Sem. Exam: 60 + Internal: 40)

Credit: 3 (2- 1- 0)

Course Outcome/Learning Outcome: This course provides an insight into the Electric, Magnetic and Electromagnetic Fields prevailing around us. At the end of this course, students will have knowledge of the origin, inter-relation and interactions of these fields in our day-to-day life. The students will also learn of the production of Electromagnetic waves as a result of interaction between Electric and magnetic fields.

Unit I:

Introduction to Fields, Mathematical and physical field, continuity, scalar and vectors, Static fields in free space, Coulomb's law, Field intensity, line of force, charge density, curl of vector, Stoke's theorem, Gauss's law, Gauss's divergence theorem, Poisson's and Laplace's equation. Electrical dipole, Double layer.

Unit II: Conductors and Dielectrics

Nature of conductors and dielectrics, polar and non-polar dielectrics. Harmonic functions. Orthogonal curvilinear, spherical and cylindrical coordinates, Method of images, Green's theorem, Green's function, Green's equivalent stratum, Dirichlet and Neumann conditions. Electric fields in conductors, Ohm's law, conductive current and displacement current, equation of continuity. Relation between resistance and capacitance.

Unit III:

Magnetic flux, Magnetic vector and scalar potentials of an electromagnetic field, induction in magnetic media, Relation between gravity and magnetic potentials. The H-field, magnetic susceptibility and permeability, boundary conditions. ferromagnetism, magnetic poles.

Unit IV:

Electromagnetic induction, law of inductions, Electric and magnetic energy densities, displacement current, electromagnetic energy and Pointing theorem. Maxwell's equations and electromagnetic waves, the wave equation, the waves in conducting media, Electromagnetic radiation from an oscillating dipole.

Recommended Books:

1. V L S Bhimasankaram, G A Soloviev & S V Seshagiri Rao, 1973: *Introduction to theory of fields*, Elseiver Scientific Pub.
2. Soloviev. G.A.: Theory of Elasticity
3. Alexander A Kaufman, 1992: *Gravitational, electric and magnetic fields*, Academic press.
4. Roy K K, 2008: *Potential theory in Applied Geophysics*, Springer, ISBN 9783540723349.
5. J D Jackson, 2007: *Classical Electrodynamics*, Wiley Student Edition, 3rd Edition.
6. David J Griffith, 2020: *Introduction to Electrodynamics*, Cambridge India, 4th Edition

Second Semester

Basin Analysis & Petroleum Geology

Course No: *GP/MJ/551*

Marks scale: 100 marks (End Sem. Exam: 60+Internal: 40)

Credit: 3 (2- 1- 0)

Course Outcome/Learning outcome: In this module, Students will learn about the formation and economic significance of sedimentary basins in petroleum system. The ultimate objective of this course is to study the application of different geophysical techniques and methods in the exploration of petroleum.

Unit-I

Concept of Basin Analysis; Basin classification and their characteristics; geothermal evolution of sedimentary basins; tectonic framework of basins and their architecture; economic significance of basin analysis; facies concept, model,process-response models and interpretation of sedimentary environments.

Unit-II

Processes and characteristics of depositional environments such as fluvial, estuarine, deltaic, lagoonal, barrier beach, tidal flats and deep sea environments; basin mapping: structure and isopach contouring, lithofacies and biofacies maps, preparation of stratigraphic cross sections and palaeogeographic synthesis.

Unit-III

History of Petroleum Exploration. Physical and chemical Properties of Hydrocarbon. Subsurface Environment - Temperature & Pressure variation with depth. Porosity & Permeability of rocks. Fluid Dynamics in the Subsurface - Fundamentals of hydrodynamics - Formation water chemistry

Unit-IV

Concept of Petroleum System; elements of a petroleum system; prospects and plays. Source rock, reservoirs rock and trap rock in Petroleum system and their characteristics. Migration of Hydrocarbon. Migration in Clastic Characteristics and control of different types of Petroleum Reservoirs (Clastic, Carbonate and Fractured). Gas hydrates - Unconventional Oil - Oil shale - Oil sands.

Recommended Books:-

1. Boggs, S. (2001): *Principles of Sedimentology and Stratigraphy*, Prentice Hall.
2. Coe, Angela, Dan Bosence, Kevin Church, Steve Flint, John Howell and Chris Wilson (2002): *The Sedimentary Record of Sea Level Change*, Cambridge Univ. Press.
3. Emery, D, (1996): *Sequence Stratigraphy*, Blachwell Scientific Publ.
4. Catuneanu, O. (2006): *Principles of Sequence Stratigraphy*, Elsevier.
5. Lindholm, R.C. (1987) *A Practical Approach to Sedimentology*, Allen and Unwin, London.
6. Miall, A.D. (2000): *Principles of Basin Analysis*, Sjpringer-Verlag.
7. Pettijohn;, F.J. (1975): *Sedimentary Rocks* (3rd Ed.), Harper and Row Publ., NewDelhi.
8. Reading, H.G. (1997): *Sedimentary Environments and facies*, Blackwell ScientificPublication.
9. Reineck, H.E. and Singh, I.B. (1973): *Depositional Sedimentary Environments*,Springer-Verlag.
10. Selley, R. C. (2000) *Applied Sedimentology*, Academic Press.
11. Tucker, M.E. (1981): *Sedimentary Petrology: An Introduction*, Wiley and Sons, NewYork.
12. Tucker, M.E. (1990): *Carbonate Sedimentolgy*, Blackwell Scientific Publication.
13. Holson, G.D. and Tiratso, E.N. (1985): *Introduction of Petroleum Geology*, Fulf Publ.Houston.
14. Jahn, F., Cook, M. and Graham, M.(1998):*Hydrocarbon Exploration and Production*,Eslevier Sc.
15. North, F.K. (1985): *Petroleum Geology*, Allen Unwin. Selley, R.C. (1998): Elements of petroleum geology, Academic Press.

Second Semester

Near Surface Geophysics & Geotechnical Modelling

Course No: *GP/MJ/552*

Marks scale: 100 marks (End Sem. Exam: 60+Internal: 40)

Credit: 3 (2- 1- 0)

Learning Objectives: Elastic and Electromagnetic Properties of Near surface soil. Understanding fundamental concept of different near-surface geophysical techniques. Understanding basics of different geotechnical modelling techniques. Understanding on the association of rock physics principles with geotechnical parameters.

Course Goal / Learning Outcome: Understanding of rock physics principles for near surface geophysics and association with geotechnical parameters.

Unit-I

Definition of near-surface geophysics, its branches and users. Near surface problems their models and fundamental parameters. Rock Physics Principles for near surface geophysics: Identity and properties of components, volume fractions of components,Geometry of the components, interaction between components. Elastic and Electromagnetic Properties of near-surface soil.

Unit-II

Concept of various Tomography, Fundamentals of up-hole seismic tomography, Crosshole seismic tomography, Up-hole Shear-wave velocity tomography and their application. Seismic Refraction Tomography and Electrical resistivity Tomography (ERT) study for near surface characterization. Basic principle and application of Multichannel Analysis of Surface waves (MASW). Data acquisition, processing and interpretation for near surface characterization.

Unit-III

Case studies of Geophysical methods (Seismic, Resistivity, EM, GPR, and Magnetic) in Near surface Geophysics (Seismic, Resistivity, EM, GPR, and Magnetic) geophysical problems: resource mapping, void/old mine working detection, coal mine fire, dam seepage, archaeological study etc.

Unit-IV

Concept of geotechnical modelling/characterization. Liquefaction and lateral spreading - Liquefaction related phenomena, Liquefaction susceptibility. Evaluation of liquefaction by cyclic stress and cyclic strain approaches, Lateral deformation and spreading, Criteria for mapping liquefaction hazard zones. Seismic Cone Penetrometer Test, Cone Penetration Test, Standard Penetration Test, Cyclic Stress Ratio, Cyclic Resistance Ratio, estimation of blow count 'N' of SPT from Shear Wave.

Text Books

1. Dwain K. Butler, 2005, Near-Surface Geophysics. SEG, 725pp.
2. Kramer, S. L., "Geotechnical Earthquake Engineering", Pearson Education.

Reference Books

1. Mark E. Everett, 2013. Near-Surface Applied Geophysics. Cambridge University Press, pp400.
2. William Lowrie, 2007, Fundamental of Geophysics. Cambridge University Press pp 381.
3. Telford, W. M., Geldart, L. P., Sheriff, R. E. and Keys, D. A., 1990, Applied Geophysics. Cambridge University Press, pp770.
4. Ansal, A., "Recent Advances in Earthquake Geotechnical Engineering and Microzonation", Springer

Second Semester

Mathematical Modelling

Course No.: AMS/MJ/550

Marks scale: 100 marks (End Sem. Exam: 60+Internal: 40)

Credit: 3 (2- 1- 0)

Course from other Departments

Second Semester

BASIC ELECTRONICS

Course No.: *GP/MN/553*

Marks Scale (Theory): 100 marks (End Sem. Exam: 60 + Int.: 40)

Credit: 2 (2- 0- 0)

Course Outcome/Learning Outcome: This course on Electronics and Instrumentation will provide students with basic concept of electronics. This course will provide them knowledge of the working of various electronic appliances and underlying physics.

Unit I:

Characteristics of, JFET, UJT, SCR & CMOS Transistors.

Amplifiers: Single stage RC coupled amplifier and its frequency response. The concept of feedback. Positive and Negative feedback. Advantages of Negative feedback. Emitter follower and Darlington Pair.

Operational amplifiers: Characteristics of ideal operational amplifiers. Feedback equation. Applications: Inverting (amplifiers); Non-inverting amplifiers, Integrator, Differential for summing amplifier, Differential amplifier, DC Voltage follower,

Unit II:

Introduction to digital gates (AND, OR, NOT & NAND) Combination logic - basic building blocks, Qualitative treatment of Multiplexers, Demultiplexes, Encoders and decoders.

Sequential logic: Basic RS flip-flop, D, T, JK flip-flop, Qualitative treatment of counters and shift registers.

Memory: Read only Memory (ROM) &, Random Access Memory (RAM).

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Recommended Books:

1. Millman and Halkias (1972): *Electronic devices and Circuits*, International student Edition, Mc Graw-Hill International Book Company.
2. D. Patranabis: *Principles of Industrial Instrumentation*.
3. W.D. Cooper (1979): *Electronic Instrumentation and Measurement techniques*, Prentice Hall of India Pvt. Ltd., New Delhi.
4. Anthony S. Maneva (1983): *Solid state electronic circuits for Engineering Technology*, McGraw – Hill, Kogakusha, Ltd., International student edition.
5. Jacob Millman & Christors C Halkias (1983): *Integrated electronics, Analog and Digital circuits and Systems*. International student edition McGraw–Hill.
6. Malvino and Leach: *Digital principles and Applications.*

Second Semester

Graph Theory
Course No.: *AMS/MN/553*

Marks scale: 100 marks (End Sem. Exam: 60+Internal: 40)
Credit: 2 (2- 0- 0)

Course from other Departments

.

Second Semester

LABORATORY-2

Course No.: GP/FP/554

Marks Scale: 100 marks (End Sem. Exam:60 + Internal:40)

Credit: 4 (0-0- 4)

Students shall perform Practical and Field works based on the following Experiments.

1. Study of important sedimentary basin of India: Assam shelf, Assam-Arakan fold belt, Rajasthan basin, Cauvery basin, Krishna-Godavari basin, Bombay offshore basin, Cambay basin, Kutch basin, Bengal basin.
2. Basin mapping and interpretations: structure, isopach contouring, lithofacies and biofacies maps.
3. Interpretation and modelling of 2D/3D Electrical resistivity Imaging or ERT.
4. Determination of dip and strike
5. Determination of joints
6. Preparation of geological mapping
7. Field instrumentation- Total Station, Resistivity meter, Magnetometer, etc.

Third Semester

SEISMOLOGY

Course No.: GP/MJ/600-A

Marks Scale: 100 marks (End Sem. Exam:60 + Internal:40)

Credit: 3 (2-1-0)

Course goal/Learning outcome: The course presents fundamental concepts of applied earthquake seismology with the objective to provide the students with a broad overview. The topics are particularly relevant to students that continue with research within earthquake seismology. However, the concepts and methods taught are also relevant to the general geo-physics student interested in Earth structure and earthquake physics. The module familiarises the students with the fundamental principles of seismometer and analysis of data.

Unit -I

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

Unit-II

Introduction, definition of an earthquake, focus, epicenter, location of the epicenter of an earthquake, classification of earthquakes – based on the depth of the focus and on the causative mechanism; Travel-time curves and velocity depth curves; Earth quake size – Intensity, magnitude and the relation between them, earthquake frequency, energy released in an earthquake; Secondary effects of an earthquake.

Continental margins: Types of continental margins – Passive, Active and transform continental margins, classification and distribution of continental margins on the globe, the global seismicity, belts of active seismicity; hotspots and mantle plumes, plume generation mechanism, evidence of mantle plumes from seismology and geoid.

Unit -III

Introduction, principle of seismometer – vertical motion seismometer, horizontal motion seismometer, the equation of seismometer – effect of instrumental damping, long period seismometer, short period seismometer, broad band seismometer; The seismogram – Analogue recording, digital recording, phases on a seismogram.

Unit -IV

Source parameters of an earthquake and their determination; Analysis of earthquake focal mechanisms – single couple and double couple radiation pattern, fault plane solutions, mechanics of faulting, focal mechanism at active plate margins, focal mechanism at continental collision zones; Earthquake prediction – prediction of the location, time and size of an earthquake, reservoir induced seismicity, seismic zonation.

Recommended Books:

1. Charles F. Richter : *Elementary Seismology*, W H Freeman & Co
2. Peter M. Shearer: *Introduction to seismology*, Cambridge University Press
3. Seth Stein & Michael Wysession : *An Introduction to Seismology, Earthquakes and Earth structure*, Blackwell Publishing
4. Thorne Lay & Terry C. Wallace: *Modern Global Seismology*, Academy Press
5. Earl V. Leary: *Earthquake, risk, monitoring and research*, Nova Science Publishers, Inc
6. Chris Chapman: *Fundamentals of Seismic Wave Propagation*, Cambridge University Press
7. Beno Gutenberg: *Internal Constitution of the Earth*, Dover Publications, Inc.
8. K.E. Bullen & Bruce A. Bolt : *An Introduction to the Theory of Seismology*, Cambridge University Press
9. P.N. Agrawal: *Engineering Seismology*, Oxford

Third Semester

REMOTE SENSING & GIS

Course No.: GP/MJ/600-B

Marks Scale: 100 marks (End Sem. Exam: 60 + Internal: 40)

Credit: 3 (2- 1- 0)

Course Outcome/Learning Outcome*:* The primary objective of this module is to acquaint the students with the Processing and analysis of Satellite digital Image and their application, fundamentals of GIS and integration of different vector and raster data in GIS.

Unit I: Remote Sensing and Electromagnetic radiation

Definition – components of remote sensing – History of Remote Sensing – Electromagnetic spectrum. Wave theory, particle theory, Boltzmann Law and Wien's Law-visible and non-visible spectrum. Radiation sources: Active and Passive. Atmospheric windows; spectral signature, spectral reflectance & emittance. Spectroradiometer/ Spectrophotometer. Typical spectral reflectance curves for vegetation, soil and water body – Factors effecting spectral reflectance of vegetation, soil and water body.

Unit II: Platforms, Sensors, Data products and Visual interpretation

Ground based platforms – Airborne platforms – Space borne platforms. Kepler's laws of planetary motion, circular and elliptical orbits of satellites, polar, Geosynchronous and geostationary satellites. Types of sensors-Photographic, single and multi-band op to mechanical, thermal sensors. Airborne and space borne TIR sensors. RADAR – SAR – LIDAR. Photographic (film and paper) and digital products – quick look product – high resolution data products. Data– ordering –interpretation –basic characteristics of image elements –interpretation keys (selective and elimination) – visual interpretation of natural resources.

Unit III: Fundamentals of GIS

Introduction to GIS– Definitions –History and Components of GIS – Hardware, software, data, People, Methods –Types of data –Spatial, Attribute data–types of Attributes –scale/level of measurements –spatial data models – Raster data structures -raster data compression –Vector data structures –Raster vs Vectormodels –TIN, DEM and GRID data models.

Unit IV: Data input, Analysis and Output

Scanner –Raster data input –Raster data file formats –Geo-referencing –Vector data input –Digitiser –Datum Projection and reprojection –coordinates transformation –Topology –Topological consistency -Raster to vector and vector to raster conversion. Entry of non-spatial data –Attribute data linking.

Simple data retrieval – Data Processing – Map overlaying and Cartographic modeling – Overlay analysis, Capabilities (Point Operations, Regional Operations, Neighborhood Operations) – Buffering – cartographic Modeling using Natural Language commands – Advantages and disadvantages of Carto-modeling – post processing of analysed outputs – Network analysis. Data output – (Types of output, GIS capabilities for output, Output devices). Map compilation.

Recommended Books:-

1. Lillesand T.M. and Kiefer R.W., 2002: *Remote Sensing and Image interpretation*, John Wiley and Sons, Inc, New York.
2. Lillesand & Kiefer : Remote Sensing and Image Interpretation.
3. Campbell, J.B.2002: *Introduction to Remote Sensing*. Taylor Publications
4. Drury, S.A., 1987: Image Interpretation in Geology.
5. Allen and Unwin Gupta, R.P.., 1990: *Remote Sensing Geology*. Springer Verlag
6. Lillesand, T.M., and Kieffer, R.M., 1987: Remote Sensing and Image Interpretation, John Wiley
7. Panda, B.C., 2005: Remote Sensing- Principles and Application.
8. Arthur, H. Robinson, 2004: *Elements of Cartography*, Seventh Edition, John Wiley and Sons.
9. Kang-Tsung Chang, 2011: *Introduction to Geographic Information Systems*, McGraw Hill Publishing, 2nd Edition.
10. Ian Heywood, Sarah Cornelius, Steve Carver, Srinivasa Raju, 2007: *An Introduction*
11. *to Geographical Information Systems*, Pearson Education, 2nd Edition.
12. Tor Bernhardsen, 2002: *Geographic Information Systems- An Introduction*, John Wiley and sons, INC. 3rd edition.
13. Burrough, P.A., 1986: *Principles of Geographical Information Systems for Land Resources Assessment*, Clarandone Press, Oxford.
14. Kang - Tsung Chang, 2002: *Introduction to Geographic Information System*, MC Graw Hill, Boston.
15. Richards, 1993: *Remote sensing digital Image Analysis-An Introduction,* Springer Verlag.

Third Semester

SOLID EARTH GEOPHYSICS

Course No.: GP/MJ/601-A

Marks Scale: 100 marks (End Sem. Exam:60 + Internal:40)

Credit: 3 (2- 1- 0)

Course Outcome/Learning Outcome: This course module introduces basic concepts of plate tectonics. At the end of this module, the student will gain comprehensive understanding of internal structure of the earth. Students are also exposed to fundamental concepts of seismology and Radiometric dating techniques.

Unit-I

History of development and scope of geophysics, monistic and dualistic hypotheses for the origin of solar system, planet and satellites of the system and their characteristics, shape and size of the earth, international gravity formula and rotation of the earth. Variation of physical quantities and seismic wave velocity inside the earth.

Unit-II

Importance of heat flow, thermal history and its characteristics over various earth surface features. Sources of heat generation and temperature distribution inside the earth, Jacob's hypothesis for liquid nature of the outer core. Geochronology: Rock dating methods, U-Th, K-Ar, Rb-Sr, C-14, Fission-Track and magnetic dating.

Unit-III

Internal constitution of the earth, characteristics of lithosphere and asthenosphere, causes of geodynamical process, geodynamic models, 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, trenchesand island arcs, hot spots, geodynamics of Indian subcontinents and formation of Himalayas, 90^0E ridge, concept of isostasy, Airy, Heiskanan and Pratt-Hayford hypotheses.

Unit -IV

Origin of geomagnetic field, polar wandering, secular variations and westward drift, reversals of geomagnetic field, geomagnetic storms, earth's current, sun spot, solar flares, lunar and solar variations, palaeomagnetic studies of rock samples and their applications in geophysics, radiometric dating principles and ages of rocks and the earth.

Recommended Books:

1. Howell: Introduction to Geophysics
2. Stacey: Physics of the Earth
3. Gubbins: Seismology and Plate Tectonics
4. Condie: Plate Tectonics and Crustal Evolution
5. Lowrie: Fundamentals of Geophysics
6. Bird & Lacks: Plate Tectonics
7. Chapman: Earth's Magnetism
8. Jacobs: Earth's Core and Geomagnetism

Third Semester

MINING GEOLOGY

Course No.: GP/MJ/601-B

Marks Scale: 100 marks (End Sem. Exam: 60 + Internal: 40)

Credit: 3 (2- 1- 0)

Course Outcome/Learning Outcome*:* This module will help the students in understanding the formation of ore and their relation to plate tectonics. It will also help in understanding the Indian distribution, occurrence and origin of different types of ores and fossil fuels and provide understanding different mining techniques employed.

Unit I: Ore Genesis

Concept of ore genesis; Distribution of ore deposits; processes of formations of ore mineral deposits; ore deposits and its relation to plate tectonics; mode of occurrence of ore bodies- morphology and relation of host rocks; texture, paragenesis and zoning of ores and their significance; concept of ore- bearing fluids, their origin and migration; wall- rock alteration; structural, physiochemical and stratigraphic control of ore localization. Geothermometry and geobarometry of ore assemblage.

Unit II: Ore deposits and occurrences

Occurrence, origin and Indian Distribution of important Mineral Deposits: Iron, Manganese, Chromium, copper, Lead, zinc, Gold, Aluminum; Mica, Thorium, Uranium. Study of following Indian ore deposits with reference to their mineralogy, mode of occurrence, origin, geological association and geographical distribution: iron, manganese, gold, aluminum, chromium, copper, lead, zinc, tin, tungsten, titanium, nickel, molybdenum; fuels: coal, petroleum, radioactive minerals and gemstones.

Unit III: Mining Techniques

Mining definition and economic importance; Mine definition, different types and classification; Mine life cycle; Mineral deposit different types and their classification; Mineral resources of India; Modes of entry to a mine shaft, incline, decline, adit and box cut. Overview of surface mining: Types of surface mines, unit operations, basic bench geometry, applicability & limitations and advantages & disadvantages. Overview of underground mining: Different coal mining methods and their applicability & limitations; Different metal mining methods and their applicability & limitations.

Unit IV: Mining Fields of India

Study of important mines in India with reference to the geological settings, ore genesis, mining plan and production status: Iron (Barabil-Koira Valley, Bailadila), Manganese (Nagpur-Bhandara, Gondites and Khondolite mine), Chromite (Sukinda and Hasan), Nickel (Sukinda and Singhbhum), Bauxite (Balangir and Koraput), Copper (Malanjkhand, Khetri, Kho-Dariba), Gold (Hutti and Ramgiri), Silver (Zawar and Tundoo), Lead (Rampura, Sindesar), Diamond (Majhgawn- Panna), Coal (Korba, Jharia, Talchir, Singrauli) and Uranium (Jaduguda, Tummalapalle, Domiasiat).

Third Semester

Recommended Books:-

1. Clark, G.B. (1967): *Elements of Mining*, John Wiley and Sons.
2. Arogyaswami, R.P.N. (1996): *Courses in Mining Geology*. 4th Ed. Oxford-IBH.
3. Moon, C.J., Whateley, M.K.G. & Evans, A.M. (2006): *Introduction to Mineral Exploration*, Blackwell Publishing.
4. Haldar, S.K. (2013): *Mineral Exploration – Principles and Applications*. Elsevier Publication.
5. Craig and Vaughan (1981): *Ore Petrography and Mineralogy*
6. Sawkins (1984): *Metal Deposits in Relation to Plate Tectonics*
7. Evans (1993): *Ore Geology and Industrial Minerals*

Third Semester

ENVIRONMENTAL PHYSICS

Course No.: GP/MN/602

Marks scale: 100 marks (End Sem. Exam:60 + Internal:40)

Credit: 2 (2- 0- 0)

Course Outcome/Learning Outcome: This course on Environmental Physics aims to make students acquaint with basic knowledge of our Environment and physics underlying the various environmental phenomenon.

Unit 1: Essentials of Environmental Physics

Structure and thermodynamics of the atmosphere. Composition of air, Greenhouse effect, Global warming, Ozone layer depletion, Heat-island effect, Hydrostatic equilibrium

Unit 2: Environmental Pollution and Climate

Factors governing air, water and noise pollution, Land and sea breeze, Wet and dry deposition, Elements of weather and climate, Solar constant, Attenuation of solar radiation in the atmosphere, Radiative properties of water, soil and leaves.

Recommended Books:

1. P. Meenakshi: *Elements of Environmental Science and Engineering*, PHI, New Delhi (2005)
2. M.H Freeman: *Standard Handbook of Hazardous Waste Treatment and Disposal*, McGraw Hill, USA. (1989)
3. P.R. Shukla, S.K.Sharma, & P.V.Raman (Eds.): *Climate Change and India*
4. P.R. Trivedi: *India's Environment*, APH Pub. Corp. New Delhi. (2004)
5. J. Monteith & M. Unswarth: *Principles of Environmental Physics,* Butterwort Heinemann (Imprint). Eds. (1990)
6. Peter Heigher & N.J. Mason: *Introduction to Environmental Physics*, CUP. (2007)

Third Semester

Classical Mechanics and fluid dynamics
Course No.: *AMS/MN/602-A*

OR
Health Statistics & Epidemiology
Course No.: *AMS/MN/602-B*

Marks Scale: 100 marks (End Sem. Exam:60 + Internal:40)

Credit 2 (2 -0 -0)

Course from other Departments

Third Semester

LABORATORY-3

Course No.: *GP/FP/603*

Marks Scale: 100 marks (End Sem. Exam:60 + Internal:40)

Credit 4 (0 -0 -4)

Students shall perform Practical and Field works based on the following Experiments.

1. Regional Field work
2. To prepare the intensity map and find out the epicentre and focal depth of an earthquake.
3. Fault plane solution using p-waves first motion
4. Identify the various faces for both body and surface waves on the given three components record.
5. Identify P and S-phases on the seismogram. Estimate i) $t_s - t_p$ ii) τ and iii) M_d. Interprete the characteristics features of the earthquake events.
6. Analysis of Seismogram for Local, Regional and Teleseismic events.
7. Travel time curves and methods of their generation
8. Process and steps to locate the epicentre of an earthquake recorded on three component seismograms.

Third Semester

Project Work

Course No.: *GP/FP/649*

Marks Scale: 100 marks (End Sem. Exam:60 + Internal:40)

Credit 6 (0 -0 -6)

Course Outcome/Learning Outcome: Every student undergoing the M.Sc. (Geophysics) Course is required to undertake a dissertation work in the third semester. The aim of this module is to instill the idea of research work in the student and prepare him to tackle a problem logically. The project may be an **Experimental investigation** based on field work and laboratory studies or a **Theoretical investigation** accompanied by computational work, data processing and analysis, or a combination of these. The exact nature of the project and the problem to be studied shall be decided at the beginning of the third semester at the Departmental Committee meeting.

Guidelines of Project Work:

1) A student will start working on the Project Work based on the Specialization Course which he/she has opted
2) The Project Work includes learning Research Methodology, Publication Ethics, etc.
3) A Supervisor will be allotted for each student to perform Project Work
4) Progress of the students will be monitored by Departmental Research Committee.

MARK DISTRIBUTION FOR PROJECT WORK:

Total marks allotted: 100

Distribution of Marks component wise:

Internal Assessment	:	**40**
As per CBCS guidelines of MZU		
External Examination	:	**60**
Break up for External Examination		
Oral Presentation:	30	
Interpretation:	10	
Viva Voce:	20	

Fourth Semester

Oceanography and Climatology

Course No.: GP/MJ/650

Marks Scale: 100 marks (End Sem. Exam:60 + Internal:40)

Credit: 4 (3- 1- 0)

Unit I: Hydrology

Hydrological cycle, Hydrologic model classification, hydrologic processes, atmospheric water, subsurface water, surface water, hydrologic measurement. Hydrologic analysis, hydrologic design. Properties of aquifers. Environmental hydrology.

Unit II: Groundwater Hydrology

Hydrological properties of water bearing materials, mode of occurrence of groundwater, groundwater movement, Surface investigation of groundwater, Sub-Surface investigation of groundwater. Artificial recharge of groundwater. Numerical modelling of groundwater flow.

Unit III: Climatology

Concept of weather and climate, classification of climate- Koppen's and Thornthwaite's scheme of classification, origin and classification of air masses, cloud formation, SW and NE Monsoons, cyclone and anticyclone, ITCZ, jet streams, ENSO, Climate change. Climate zones of India

Unit IV: Meteorology

Thermal structure of the atmosphere and its composition; tropical convection; Atmospheric electricity (Electrical field in thunderstorms, theories of thunderstorm classification); cloud physics (Cloud classification, growth of cloud drops and ice- crystal, precipitation mechanisms, Bergeron, Findeisen process, rain drop spectra), dynamic meteorology; Numerical Weather Prediction. Meteorological satellites.

Recommended books:-

1. Chow VT, Maidment DR & Mays LW (1988): *Applied Hydrology*, McGraw-Hill
2. Fetter CW: *Applied Hydrogeology*, Prentice Hall
3. Ojha CSP, Berndtsson R & Bhunya P (2008): *Engineering Hydrology*, Oxford University Press.
4. Singh VP (Ed.): *Environmental Hydrology*, Water Science and Technology Libraryvol 15, Springer.
5. Todd DK (1980): *Groundwater Hydrology*, Willey
6. K Subramanya, 2020: *Engineering Hydrology*, McGraw-Hill, 5th Edition.
7. M J Deodhar, 2008: *Elementary Engineering Hydrology*, Pearson Education.

Fourth Semester

LABORATORY-4

Course No.: GP/FP/651

Marks Scale: 100 marks (End Sem. Exam:60 + Internal:40)

Credit: 4 (0- 0- 4)

Students shall perform Practical and Field works based on the following Experiments.

1. Determination of permeability, transmissivity and storativity by discharging method.
2. Analysis of hydrograph
3. Analysis of global distribution of mean climatic parameters
4. Computation of climatic types according to Koppen and Thornthwaite
5. Preparation of water - table maps and determination of ground water flow directions.3-point problems.
6. Determination of permeability by Falling Head and Constant Head method.
7. Problems on pumping test.

Fourth Semester

Dissertation

Course No.: GP/FP/699

Marks Scale: 100 marks (End Sem. Exam:60 + Internal:40)

Credit: 12 (0- 0- 12)

PROJECT WORK FOR M.Sc. DISSERTATION

Course GP/4/RP/02 is continuation of the Project Work (GP/3/RP/01) in the Third Semester for dissertation of full marks 100 offered in the curriculum of the M.Sc. Geophysics Course.

Course Objectives:

a) To provide student with skill and knowledge in conducting research in fundamental and application aspects of Geophysics.

b) To train students in developing analytical as well as argumentative skill.

Evaluation of the Dissertation:

The thesis/dissertation shall be evaluated by a Board of Examiners consisting of Supervisor, Head of concerned Department and an External Examiner approved by Vice Chancellor as per CAGP guidelines of Mizoram University. The evaluation of the dissertation shall be completed before the commencement of 4th Semester Theory Examinations. The dissertation as evaluated by this Board will be final. It is to be noted that copy and pasting of articles from internet without proper permission, copying from dissertation or thesis without quoting proper references will not be accepted. If any kind of plagiarism is practiced by the student, his/her dissertation work shall be liable to be rejected.

MARK DISTRIBUTION FOR PROJECT WORK:

MARK DISTRIBUTION FOR DISSERTATION:

Total marks allotted: 100

Distribution of Marks component wise:

Internal Assessment : 40

(As per CAGP guidelines of MZU)

External Examination : 60

Dissertation : 40

Publication(s) : 20

Programme Outcome:

Geophysics, as a discipline has been contributing significantly to the society, it plays a pivotal role in both efficient and sustainable use and exploration of the Earth's resources in terms of minerals and petroleum. It has emerged as a new field of research for fulfilling the rapidly growing needs of the society. By drawing scientific attention on the development of novel techniques based on creativity and innovation and working together on contemporary challenges using concrete and comprehensive database.

Numerous geophysical techniques have been proven necessary and effective for discovering mineral deposits, oil/gas deposits, and for uncovering riddles inside the Earth. Moreover, the characteristics of heterogeneities bear important insights in many aspects, for instance, the dynamic processes and evolution of the lithosphere including occurrences of frequent earthquakes, tsunamis, volcanism as well as phase and chemical composition changes in the interior of the Earth.

The present 2-Year MSc Geophysics is designed to produce high quality intellectually accomplished manpower to take leadership role to cater to the needs of different segments of Indian and global economy- industry, infrastructure and service sectors, Research & Development and design organizations, educational institutions, etc. It provides education for comprehensive understanding of deep earth processes and their evolution, exploration and its manifestations to subsurface/ near surface process phenomena and its impact on earth and its environment. It is an interdisciplinary education programme comprising of solid earth geophysics, mineralogy and petrology, structural geology and sedimentology, seismology, Advanced seismic interpretation, geoelectrical methods, groundwater geophysics etc.

The course imparts theoretical and practical knowledge of the Mother Earth and its resources, both for exploration as well as understanding the deeper-earth tectonics to expose the students to the latest research and developments in science and technology for the benefit of human society at large.