M.S (Tech) Applied Geo Physics

(Effective from the admitted batch of 2021-22)

Scheme and Syllabus

DEPARTMENT OF GEOPHYSICS
COLLEGE OF SCIENCE AND TECHNOLOGY
ANDHRA UNIVERSITY, VISAKHAPATNAM

PROGRAM EDUCATIONAL OBJECTIVES(PEOs)

Post Graduates of the Program will

PEO 1	Be successful in diverse career paths in Geophysics or allied industries
PEO 2	Enhance problem-solving skills that involve designing and conducting experiments, analyzing and interpreting data.
PEO 3	Continue professional development by active participation in professional society activities.
PEO 4	Display lifelong learning through continuing education or postgraduate education.

PROGRAM OUTCOMES (POs)

After successful completion of the program, the post graduates will be able to

PO 1	Apply knowledge of geophysics to the solution of complex geological problems.
PO 2	Identify, formulate, research literature and analyze complex engineering problems, reaching substantiated conclusions using first principles
PO 3	Design solutions for complex engineering problems and design systems, components or process that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental and considerations.
PO 4	Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.
PO 5	Create, select and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO 6	Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
PO 7	Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of, and need for sustainable development.
PO 8	Apply ethical principles and commit to professional ethics and

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	responsibilities and norms of engineering practice.
PO 9	Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.
PO 10	Communicate effectively on complex geophysical activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and deign documentation, make effective presentations and give and receive clear instructions.
PO 11	Demonstrate knowledge and understanding of engineering management principles and apply these to one's own work, a a member and leader in a team and to manage projects in multidisciplinary environments.
PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning.

PROGRAM SPECIFICATION OUTCOMES (PSOs)

PSO 1	Be proficient in Marine Geophysics, Groundwater and Geophysical industry.
PSO 2	Design and analysis of well systems and procedures for drilling and completing wells and increase the production of the oil and gas.
PSO 3	Characterization and evaluation of subsurface geological formations and their resources using geological and geophysical and engineering methods.
PSO 4	Application of reservoir engineering principles and practices of engineering resource development and effective management for the benefit of the society in sustained manner.

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Learning outcomes in M.Sc(Tech), M.Sc(Marine) Geophysics are:

After successful completion of the program, the post graduates will be able to

LO1	The objective of the post graduate program in Geophysics is to prepare students to be leaders in the geophysics industry, academia, and research organizations through completion of courses. Students are expected to:
LO2	apply skills developed in fundamental courses to geophysical problems
LO3	research, analyze, and synthesize solutions to an original and contemporary geophysics problem.
LO4	work independently and as part of a team to develop and improve geophysics solutions
LO5	apply written, visual, and oral presentation skills to communicate scientific knowledge.
LO6	master's students are expected to develop an in-depth technical understanding of geophysics problems at an advanced level.
LO7	doctoral students are expected to complete a scientific investigation that is significant, challenging and original
LO8	Geophysics means physics of the Earth, and you will learn about the different techniques used to map and analyze the physical properties of the Earth.
LO9	Seismic prospecting and well logging are core methods in geophysical methods at all scales and is therefore central in this study
LO10	Electrical, Electromagnetic methods, analysis of the gravity and magnetic fields, geomagnetism, groundwater studies are also important aspects
LO11	Marine Geophysics, Geodynamics, Petroleum Geology and Geophysics are learned in this studies.
LO12	Mining, Environmental Hydrology, water resources, Micropaleontology, Sequence stratitragphy, disaster Managment are also important aspects of the studies.
LO13	Computational skills are essential in geophysics and you will be trained using modern computer facilities for processing, interpretation, modelling and visualization of geological and geophysical data. You will also learn to program some small codes yourself. Some courses have a field component. Training in oral and written presentation of scientific results is an integrated part of the study.
LO14	The study also provides a solid basis if you want to pursue your studies towards a Ph.D.

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COLLEGE OF SCIENCE & TECHNOLOGY
DEPARTMENT OF GEOPHYSICS

Effective for the Batch of students admitted from 2016-17 academic year

M.Sc. (Tech.) GEOPHYSICS:

Semester – I

		L	P	Total	Exam. Marks	Mid Sem. Marks	Total Marks	Credits
Theory								
Code	Subject							
GS 101	Elements of Geology	4		4	80	20	100	4
GS 102	Numerical Analysis & Computer Programming	4		4	80	20	100	4
GS 103	Earth System Science	4		4	80	20	100	4
GS 104	Seismology	4		4	80	20	100	4
Practicals								
GS 105	Elements of Geology		3	3	50		50	2
GS 106	Numerical Analysis & Computer Programming		3	3	50		50	2
GS 107	Seismology		3	3	50		50	2
GS 108	Viva-Voce				50		50	2
	Total	16	9	25	520	80	600	24

Semester – II

		L	P	Total	Exam. Marks	Mid Sem. Marks	Total Marks	Credits
Theory								
GS 201	Economic & Petroleum Geology & Stratigraphy	4		4	80	20	100	4
GS 202	Solid Earth Geophysics	4		4	80	20	100	4
GS 203	Remote Sensing & GIS	4		4	80	20	100	4
GS 204	Geophysical Signal Processing & Inversion Theory	4		4	80	20	100	4
Practicals								
GS 205	Economic &Petroleum Geology &Stratigraphy		3	3	50		50	2
GS 206	Remote Sensing & GIS		3	3	50		50	2
	Geophysical Signal Processing & Inversion Theory		3	3	50		50	2
GS 207	Viva-Voce				50		50	2
	Total	16	9	25	520	80	600	24

Contd...

Semester –III

		L	P	Total	Exam Marks	Mid Sem. Marks	Total Marks	Credits
Theory								
GS 301	Gravity Method	4		4	80	20	100	4
GS 302	Electrical Methods of Exploration	4		4	80	20	100	4
GS 303	Seismic Prospecting	4		4	80	20	100	4
GS 304	Well Logging and Reservoir Analysis	4		4	80	20	100	4
Practicals								
GS 305	Gravity Method		3	3	50		50	2
GS 306	Electrical Methods of Exploration		3	3	50		50	2
GS 307	Seismic Prospecting		3	3	50		50	2
GS 308	Well Logging and Reservoir Analysis		3	3	50		50	2
GS 309	Viva-Voce				50		50	2
	Total	16	12	28	570	80	650	26

Semester –IV

		L	P	Total	Exam Marks	Mid Sem. Marks	Total Marks	Credits
Theory								
GS 401	Magnetic Method	4		4	80	20	100	4
GS 402	Electromagnetic Methods of Exploration	4		4	80	20	100	4
GS 403	Seismic data processing and Seismic Stratigraphy	4		4	80	20	100	4
GS 404	Marine Geophysics	4		4	80	20	100	4
Practicals								
GS 405	Magnetic Method		3	3	50		50	2
GS 406	Electromagnetic Methods of Exploration		3	3	50		50	2
GS 407	Seismic data processing and Seismic Stratigraphy		3	3	50		50	2
GS 408	Marine Geophysics		3	3	50		50	2
GS 409	Viva-Voce				50		50	2
	Total	16	12	28	570	80	650	26

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Semester – V

		L	P	Total	Exam Marks	Mid Sem. Marks	Total Marks	Credits
Theory								
GS 501	Mining & Ground water and Environmental Geophysics	4		4	80	20	100	4
GS 502	Environmental Hydrolgy& Water quality	4		4	80	20	100	4
GS 503	Petroleum Geology & Geophysics	4		4	80	20	100	4
GS 504	Disaster Management	4		4	80	20	100	4
Practicals								
GS 505	Mining & Ground water and Environmental Geophysics		3	3	50		50	2
GS 506	Environmental Hydrolgy& Water quality		3	3	50		50	2
GS 507	Seminar		3	3	50		50	2
GS 508	Viva-Voce				50		50	2
	Total	16	09	25	520	80	600	24

Semester – VI

		L	P	Total	Exam Marks	Mid Sem. Marks	Total Marks	Credits
Theory								
GS 601	Water Resources, planning and Management	4		4	80	20	100	4
GS 602	Geodynamics	4		4	80	20	100	4
GS 603	Sequence stratigraphy and basin analysis	4		4	80	20	100	4
GS 604	Micropaleontolgy, CBM and Gas hydrate Exploration	4		4	80	20	100	4
Practicals								
GS 605	Sequence stratigraphy and basin analysis		3	3	50		50	2
GS 606	Group Discussion		3	3	50		50	2
GS 607	Project dissertation		3	3	100		100	4
GS 608	Comprehensive Viva				100		100	4
	Total	16	09	25	620	80	700	28

Elements Of Geology			
Common syllabus for M.Sc (Tech) Geophysics- I semester			
Course Category	Basic Science core course	Course Code	GS-101
Course Type	Theory	Lectures-Training-Practical	4-0-3
Prerequisites	Basics of the Mathematics & Physics	Internal Assessment Semester End Examination Total Marks	20 80 100

Course Objectives

1. To address thedifferent branches of geology
2. To Provide basic understanding of geological work of rivers and concepts of Geomorphology
3. To create understanding on the rocks and minerals

M. Sc (Tech) Geophysics **ANNEXURE3**

I SEMESTER

GS-101 ELEMENTS OF GEOLOGY

UNIT – I

Introduction to Geology– Branches of Geology - Scope of Geology and its relation with Geophysics. Weathering and erosion Phenomenon – Physical, chemical and Biological weathering - products of weathering. Wind erosion and its features - Sediment transport by wind - various types of Dunes. Geological work of Glaciers – Types – Movement - Erosional features. Glacial Transport – Deposition and related features.

UNIT-II

Geological work of Rivers - Initial, Young and old stages of their development - Canyon, base level of erosion, meandering point bors, oxbow lakes, flood plains and natural levees. Erosion, denudation, peneplains, monad nocks, deltas and types. Volcanoes – Types, Products, Volcanic eruptions, and distribution ofVolcanoes.

UNIT-III

Fundamental concepts of Geomorphology. Various near shore morphological features developed due to geological work of sea. Waves and currents and transportation by sea. Features of Marine erosion and deposition and related features. Evolution of major geomorphic processes in India, Field and laboratory map scales, Topographic maps Thematicmaps.

UNIT-IV

Definition of Petrology –Bowen's reaction series – Differentiation of Igneous, Sedimentary and Metamorphic rocks. Origin and forms of Igneous rocks – textures – structures and classification of Igneous rocks. Origin of sedimentary rocks, textures – structures and classification of sedimentary rocks. Types of Metamorphism - Textures and structures of Metamorphic rocks.

UNIT-V

Definition of a mineral – Physical properties of minerals: Mohs scale of hardness, colour, streak, transparency, luster, tenacity, cleavage, fracture, specific gravity, - Isomorphism and Polymorphism – Structure and chemistry of Quartz, Feldspars, Mica Pyroxenes, Amphiboles, Garnet groups of minerals. Clay minerals, Elements of Crystallography.

REFERENCE BOOKS: 1) Physical Geology: G. Gorshkov, A. Yakushova.
2) Physical Geology: A.K.Datta
3) A text book of Geology: P.K.Mukherjee.
4) The Principle of petrology: G.W.Tprell.
5) Rutleys mineralogy: H. M.Read.
6) Physical Geology: Arthur Holmes.

7) Principle of Engineering Geology: K. M.Bangar.
8) A text book of Geology: G.B.Mahapatra.
9) A text book of Physical Geology: G. B.Mahapatra.
10) Engineering and general Geology: Parbinsingh.

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Upon the successful completion of the course will provide		Cognitive Level
CO1	Students will understand the scope of geology in the field of Geophysics as it is (Geological structures and processes) the ultimate objective of Geophysics.	Understanding
CO2	The students will be acquainted with The knowledge on the morphological features formed in different stages of river development.	Understanding
CO3	The students will be familiar with identifying and understanding the symbols and features in different thematic and topographical maps.	Understanding
CO4	The students will be acquainted with the knowledge in differentiating the types of rocks.	Analysing
CO5	The students will learn about the formation and classification of minerals	Analysing

Course Specific Outcome (CSOs)

CSO1 It gives a basic understanding on the elements of geology
CSO2 It gives an insight on geological work of river, sea, wind& volcanic eruptions
CSO3 The students will learn about the topographic maps and groups of minerals

Learning Outcomes (LOs)

LO1: After the course, students will have broad understanding on the basic knowledge of geology in the evolution of different geomorphological features developed by the work of wind and glaciers.
LO2: Students will learn the formation and distribution of Volcanoes.
LO3: They will also learn how to generate the topographical maps with elevation data.
LO4: They will identify the structures in different types of rocks
LO5: They also will be aware of the occurrence and distribution of economic minerals in India.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO 1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO2**
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	1	1	2	1	-	-	-	-	-	-	-	-	-	2
CO3	3	1	2	-	-	-	-	-	-	-	1	-	1	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	2
CO5	2	2	2	-	-	-	-	-	-	-	-	-	1	1

GS 102: Numerical Analysis & Computer programming			
M.Sc (Tech) Geophysics- I semester			
Course Category	Basic Science core course	Course Code	GS-102
Course Type	Theory	Lectures-Training-Practical	4-0-3
Prerequisites	Basics of the Mathematics & Physics	Internal Assessment Semester End Examination Total Marks	20 80 100

Course Objectives

1. To provide introduction of Numerical analysis
2. To create the knowledge on the usage of commuter programming for application of Numerical Analysis
3. To provide knowledge on the UNIX, FOTRAN, and C language.

M.Sc (Tech) Geophysics

I SEMESTER

GS 102: Numerical Analysis & Computer programming

UnitI: Numerical Analysis; finding the roots by numerical methods- bisection method, False position method, Newton-Raphson method. Interpolation: finite difference, symbolic relations. Interpolation by Newton's formula. Gauss's Central difference formula, Bessel's formula, Lagrangian formula and Richardson's extrapolation. Numerical differentiation and Integration: Maximum and minimum of a tabulated function. Numerical Integration-Trapezoidal rule, Simpson' s rule, Romberg integration, Weddle's formula.

UnitII: Numerical solution of differential equations- Introduction, Solution by Taylor series, Picard's method of successive approximation, Euler's method, Runga-Kuttamethod. Finite element methods: Basic concept of the finite element method. Boundary and Initial value problems, Classical Optimization Techniques-The Ritz method, I-D and 2-D problems. Linear and Non-linear Programming, One dimensional minimization, Fibonacci method, Unconstrained optimization, Steepest descent method, gradient techniques and Marquardt'smethod.

UnitIII: Introduction: General architecture of a computer. Types of computers, Structure of a computer, programming languages Low level and High Level, object program, compilers and assemblers. Algorithm, Flowchart, Different types of operating systems, MSDOS; Multi-tasking operating system- MS WINDOWS, Multi-user and multi-tasking operating systems- UNIX, File system in UNIX, File management, UNIX commands and Shell programming.

Unit IV: Structure of FORTRAN-77, programming preliminaries, Constant and Variables, expressions- Statements Library functions, Control statements - GOTO, Logical expressions, DO statement & Nesting, STOP, END and PAUSE statements; subscripted variables. Arrays and DIMENSION statement; Special statements - COMMON, DATA

statements. Input and Output statements; Subprograms –SAVE & EQUIVALANCE, Function and Subroutines Double Precision. Programming Examples in Fortran to handle GeophysicalProblems.

UnitV: C programming language: Basic concepts of C; Symbolic and arithmetic constants and variables; Data types in C Decision control. Loop control and Case control structures in C; Functions; Pointers and Arrays; Input and Output; Iteration with Hardware through C and Operations on Bits; Some selected Geophysical problems and their Cprograms.

Books:

1. Generalized inverse of matrices and its application, C.K.Rao&S.R.Mitra
2. An Introduction to Finite Element Method,J.N.Reddy
3. Introduction to Numerical analysis,S.S.Sastry
4. Introduction to Numerical analysis,F.B.Hiderbrand
5. Optimisation theory and application,S.S.Rao
6. Fortran programming. A.K. Jain &M.N.KesavaRao
7. Fortran 77 programming, V.Rajararnan,
8. Let us C, YashavantKanetkar
9. UNIX shell programming , YashavantKanetkar

Upon the successful completion of the course will provide		**Cognitive Level**
CO1	❖ To impart knowledge on the solution of transcendental equations.	Understanding
CO2	❖ To provide an insight in solving non-linear problems .	Understanding
CO3	❖ To provide basic information on the history of computers, Types of computers, General concepts related to software	Understanding
CO4	❖ To provide the knowledge on the usage of Fortran programming language in solving various geophysical problems	Analysing
CO5	❖ To provide the knowledge on the usage of C programming in solving various geophysical problems	Analysing

Course Specific Outcome (CSOs)

CSO1 Students become familiar with interpolation and extrapolation techniques.

CSO2 Student will learn the classical optimization techniques.

CSO3 It provides insight on the algorithms, flowcharts, operating systems, and computer languages.

Learning Outcomes (LOs)

LO1: It provides how to solve various problems in Geophysics with numerical analysis
LO2: Students will learn about the usage of Numerical solution of differential equations in geophysics
LO3: Students will be acquainted the knowledge on Multi-user and multi-tasking operating systems
LO4: Student will learn the basic knowledge on the FOTRAN language and its applications in solving the geophysical problems
LO5: Student will learn the basic knowledge on the C language and its applications in solving the geophysical problems

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO 1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO2**
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	1	1	2	1	-	-	-	-	-	-	-	-	-	2
CO3	3	1	2	-	-	-	-	-	-	-	1	-	1	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	2
CO5	2	2	2	-	-	-	-	-	-	-	-	-	1	1

EARTH SYSTEM SCIENCE			
M.Sc (Tech) Geophysics- I semester			
Course Category	Basic Science core course	Course Code	GS-103
Course Type	Theory	Lectures-Training-Practical	4-0-0
Prerequisites	Basics of the Mathematics & Physics	Internal Assessment Semester End Examination Total Marks	20 80 100

M.Sc (Tech) Geophysics
I SEMESTER **GS 103 - EARTH SYSTEM SCIENCE**

Course Objectives

Upon completion of this course, the students will acquire and understanding of the following topics:

1. To educate the student in science of horizon of the earth , Geohydrology and geochronology
2. To provide knowledge on general meteorology including cyclones, air masses, fronts and also on climatic types and global warming
3. To impart general knowledge on the physical Oceanography. Instrumentationinre fraction& reflection surveys. Digital seismic data recording.

UnitI: Origin of the earth- the Universe and our galaxy, chemical evolution of galaxy formation of the earth and planets, primary differentiation of the earth. Composition of the various zones, abundance of elements in the earth, the rotation of the earth, the moon, salient concepts of plate tectonics. The earth's gravity field, the force of gravity on the surface of the earth, the figure of the earth, Clairaut's theorem, the geometric and gravitational flattening, International gravity formula, geoid and spheroid, the gravitypotential

Unit II: Geochronology, Radioactive decay. Dating of rocks - potassium-argon – rubidium strontium-uranium-lead-carbon 14 methods, age of the earth. The earth's thermal properties, the basic thermal data, the measurement of terrestrial flow, calculation and analysis of heat flow rate, heat flow over the ocean floor, flow over continents, sources of heat in the earth, temperature distribution in earth. The equality of continental and oceanic heat flows, regions of anomalous flow, hot spots, relationship of heat flow to the radioactivity of theearth.

UnitIII: Geohydrology: Hydrological cycle, origin of ground water, subsurface distribution of water, springs. Hydrological properties of water bearing materials: porosity, void ratio, permeability, transmissivity, storativity, specific yield, specific retention, diffusivity, laboratory methods of determination of perrmeability. Mode of occurrence of Groundwater: Classification of rocks with respect to their water bearing characteristics aquifers, aquicludes, aquitards, classification of aquifers and ground water province. Evaporation, evapotranspiration, seepage, infiltration and run off. Hydrogeochemistry : Physical and chemical characteristics of ground water, classification of ground water with respect to domestic irrigation and industrial use, pollution of groundwater.

Unit IV: General Meteorology: surface, self recording and upper an meteorological instruments, aneroid barometer, barograph, air thermometers, psychromoter, hair hydrograph, cup anemamoter, ordinary and recording rainguages, sunshine recorder, pilot ballon, theodolit, radiosonde, Rawin and Radar. The Atmosphere; composition and structure; Air pressure & winds; general circulation of the atmosphere; monsoons, local winds, Humidity, Fog & Clouds, precipitation, Air masses, fronts, atmospheric disturbances of climate, cyclones, anticyclones and tornadoes, hurricanes, air masses and fronts, jet

streams, Koppers classification, Thornawite, classifications, Trewertha's classification, Climatic types and their distribution climatic changes, applied climatology, Air pollution, Global warming, Green houseeffect.

Unit V: Physical oceanography: Physical properties of sea water temperature of the oceans, water masses, bottom relief of the oceans, the morphology of the ocean bottom. Chlorinity, salinity, thermal properties, density, optical properties, water masses, T-S diagram, heat budget of the ocean, Bowen reaction. Salinity Density measurement, Nansen bottle, light in sea, reversing thermometers, battery thermograph, current meters, ocean currents of the world, Eli-nano, upwelling & sinking waves, breakers, surf, internal waves, storm surges, Tsunami tides, tide generating force, types of tides, prediction of tides, tide gauge, Air sea interaction.

Books:

1. Introduction of Geophysics,Howell
2. Physics and Geology, Jacobs andRussel
3. Physics of the earth,Stacy
4. The interior of the earth, M.H.P.Bott
6. Fundamentals of Geophysics, WilliamLowrie
7. Groundwater Hydrology, D.K.Todd
8. General Climatology, HJ.Critchfield
9. Earth, Press &Siever
10. Climatology & Oceanography, D.S.Lal
11. The Ocean their physics, chemistry and General Biology by H.U. Sverdrup, MatrinW. Johnson, Richard H.Fleming

Upon the successful completion of the course will provide		**Cognitive Level**
CO1	To provide the basic concepts of the earth universe and galaxy.	Understanding
CO2	To provide basic idea of radioactive decay.	Understanding
CO3	To provide the over view of hydrological cycle.	Understanding
CO4	To inculcate the basic knowledge on meteorological instruments, atmosphere and climate.	Analysing
CO5	To educate on the physical properties of waves and tides.	Analysing

Course Specific Outcome (CSOs)

CSO1 Students become familiar with earth system science by learning the origin of the earth and heat transfer for the ocean floor.

CSO2 The students can understand the classification of rocks physical and chemical properties of ground water.

CSO3 The student will gain knowledge on the climatic system and the physical features of Oceanography.

Learning Outcomes (LOs)

LO1: After the completion of the course the student will have broad understanding on the earth gravity field and abundance of elements of earth.

LO2: The student can understand the sources of hear in the earth and the heat flow relationship with radioactivity of the earth

LO3: It gives an insight to the students on the origin of ground water, evaporation and evapotranspiration.

LO4: The students will be educated on the basic concepts of air masses, climatic classification, Global warming and the importance of green house effect.

LO5: The students will be acquainted with the knowledge on the TS diagram, head budget of ocean unwilling and sinking and their importance.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	1	1	2	1	-	-	-	-	-	-	-	-	-	2
CO3	3	1	2	-	-	-	-	-	-	-	1	-	1	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	2
CO5	2	2	2	-	-	-	-	-	-	-	-	-	1	1

SEISMOLOGY			
Common syllabus for M.SC (Tech.) Geophysics and M.Sc. Marine Geophysics - I semester			
Course Category	Basic Science core course	Course Code	**GS-104**
Course Type	Theory	Lectures-Training-Practical	4-0-4
Prerequisites	Basic Mathematics and Physics (waves and oscillations)	Internal Assessment Semester End Examination Total Marks	20 80 100

Course Objectives

4. To understand the composition and state of the planet's interior.
5. Understand types of seismic waves and how the earthquakes occur.
6. Various instruments used tin Recording the earthquake.
7. Determine the epicenter, magnitude of the earthquake and understand the focal mechanism of earthquake.
8. To understand the most sensitive zones of seismicity and hazards of earth

M.Sc (Tech) Geophysics
I SEMESTER
GS-104 SEISMOLOGY

Unit I:
Introduction to seismology. Elastic waves- Elastic, Anelastic and Plastic behavior of materials. Stress, Strain, elastic constants. Seismic waves- Introduction, Body waves. Surface Waves, Types and Phases of waves. Free oscillations of the Earth, the internal Structure of the Earth- Refraction and Reflection in the earth's interior. Types of Earthquakes.

Unit II:
Seismometry: Introduction, Principle of Seismometer, Vertical motion seismometer, and Horizontal motion seismometer. Broad Band seismometer, Analog recorders. Digital recorders, Seismogram- Identification of Phases on a seismogram. Selection of seismograph stations. Global seismic network

Unit III:
Travel-Time curves, Seismogram Interpretation, locating earthquakes. Earthquake intensity Magnitude, Frequency, Energy released in an earthquake. Epicenter determination Seismic Sources - Faults, Introduction of earthquake focal mechanism, Single- Couple and Double couple radiation patterns.

Unit IV:
Analysis of earthquake focal Mechanism, Mechanics of faulting, Fault-plane solutions. Micro earthquakes- Analysis and interpretation of seismograms, Reservoir induced earthquakes. Prediction of location of the earthquake. Earthquake control. Monitoring of Nuclear explosions. Hydro seismicity, rain induced seismicity.

Unit V:
Earthquakes and Plate Tectonics: Intra plate seismicity, earthquakes in oceans, tsunami, inter plate seismicity, Continental earthquakes and tectonics. Faulting and Fracture, Secondary effects of earthquakes: landslides, fires and fatalities, Seismicity of India and Globe, Seismic zoning. Earthquake effects and hazards.

Books:
1. Fundamentals of Geophysics, William Lowrie
2. Modem Global Seismology, Thorne Lay
3. Earthquakes, Bolt, B.A.,
4. Introduction to Seismology, Perry Byrle
5. The Earth, Jeffreys.S.H.
6. Elementary Seismology, Charles.F. Richter
7. Earthquake Mechanics, Kasahara. K.
8. The Mechanics of Earthquakes-faulting, Scholtz.C.H.
9. An introduction to the theory of seismology, Bullen. K.E.
10. Quantitative seismology: theory & methods, Aki. K. and Richrds. P.G

COs	**Upon successful completion of the course, the student will be able to:**	Cognitive level
CO1	Understand the types of seismic waves and principles involved in determining the composition and state of the planet's interior	Understanding
CO2	Recording of earthquakes with various seismometers,	Knowledge
CO3	Determine the epicenter, magnitude of the earthquake and understand the focal mechanism of earthquake	Knowledge
CO4	Analysis and interpretation of seismogram	Knowledge
CO5	Seismic active zones and Hazards caused by earthquakes	Understanding

Course Outcomes (COS):

1. Will be able to understand the types of seismic waves and propagation within the earth.
2. How the seismology has been used to determine the internal composition and structure of the earth
3. How the record process is done to monitor the earthquake
4. Understand different types of instruments used to record low and high magnitude earthquakes.
5. What are the earthquake prone zones and how can they be handled
6. Hazards caused by earthquakes.

Course Learning Outcomes (CLOs)

Upon successful completion, students will have the knowledge and skills to:

1. Understand the types of seismic waves and their propagation
2. How the elastic properties of materials influence the propagation of seismic waves.
3. How to determine the epicenter and focal point of earthquake
4. Recording, identifying and processing of seismic waves.
5. Understand the low and high seismic active zones and forecast the seriousness of earthquakes.

Contribution of Course Outcomes towards achievement of Program													
Outcomes (1 – Low, 2 - Medium, 3 – High)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	3	2	-	-	-	-	-	-	-	-	-	-	2
CO2	1	2	2	1	-	-	-	-	-	-	-	-	-	3
CO3	3	1	2	-	-	-	-	-	-	-	1	-	1	2
CO4	2	2	1	-	-	-	-	-	-	-	-	-	-	2
CO5	3	2	2	-	-	-	-	-	-	-	-	-	1	2

ECONOMIC AND PETROLEUM GEOLOGY & STRATIGRAPHY			
M.Sc (Tech) Geophysics- II semester			
Course Category	Basic Science core course	Course Code	GS-201
Course Type	Theory	Lectures-Training-Practical	4-0-3
Prerequisites	Basics of the Mathematics & Physics	Internal Assessment Semester End Examination Total Marks	20 80 100

Course Objectives

Upon completion of this course, the students will acquire and understanding of the following topics:

1. The students will be acquainted knowledge on the economic mineral deposits and physiographic divisions and important indian groups and systems.
2. The students will gain necessary knowledge on the structural features of rocks and their importance.
3. The students will be acquainted knowledge on the economic mineral deposits and physiographic divisions and important indian groups and systems.

M.Sc (Tech) Geophysics

SEMESTER II

GS-201 ECONOMIC AND PETROLEUM GEOLOGY & STRATIGRAPHY

UNIT-I

Stratigraphy: Introduction - principles of Correlation. Fossils - uses of fossils - their importance in statigraphy Physiographic divisions of India - Peninsular India, Indogangitic plain and Extra peninsular India. Geological time scale and Stratigraphic units of India.

UNIT-II

Important Indian groups and systems: Archean and Dharwar System – Introduction, distribution, classification and economic importance. Study of Cuddapah – Vindhyan – Gondwana group – Deccan traps – Siwaliks and Quaternary formations.

UNIT-III

Structural features of rocks. Stress and strain. Primary and secondary structures – dip and strike. Folds: Introduction – classification and origin. Faults: Introduction – classification and recognition and causes of faulting. Joints: Introduction – classification and origin. Unconformities: Definition – Origin andtypes.

UNIT-IV

Economic mineral deposits: Origin of ore deposits – Igneous, sedimentary and metamorphic. – Metallic and Non metallic types - Placer minerals. Classification of coals - Origin, migration and entrapment of petroleum deposits with special reference to KG basin.

UNIT-V

Physiographic divisions of seas and world oceans, Seamounts and guyots – Properties of sea water: Temperature, salinity and density — Hotspot mechanism – turbidity currents – Mid oceanic ridge system – Coral reefs and their formation – Island arcs – trenches – Deep sea sediments: placers on the

beach and shelves - Conditions for formation of polymettallic nodules.

REFERENCEBOOKS:

1) Physical and engineering geology: S.K.Garg

2) A text book of geology: G.B.Mahapatra.

3) Principles of engineering geology: K.M.Bangar.

4) Submarine geology: P.H.Kunen.

5) Submarine geology: F.P.Sheppard.

6) Stratigraphy of India: M.S.Krishnan.

7) Structural geology: M.P.Billings.

8) Economic mineral deposits: A. M.Bateman.

9) Text book of Physical geology: G.B.Mahapatra.

contd...

Upon the successful completion of the course will provide		Cognitive Level
CO1	To provide knowledge on the uses of fossils.	Understanding
CO2	To educate the student on the important indian groups like cuddapah, vindhayan, Deccan traps and Gondwana.	Understanding
CO3	To educate the student in identifying faults, folds and joints in different rocks.	Understanding
CO4	To impart knowledge on grading the coal and hydrocarbons.	Analysing
CO5	To educate on the properties of sea water and deep sea sediments.	Analysing

Course Specific Outcome (CSOs)

CSO1 The students become familiar in understanding the physiographic divisions of india and importance of rocks.

CSO2 The students become familiar in the classification of joints and unconformities in rocks.

CSO3 The students become familiar in the classification of coals and can understand conditions for formation of polymettallic nodules.

Learning Outcomes (LOs)

LO1: The students will have broad understanding on the demarcation of the physiographic divisions of India.
LO2: The students can understand the rocks which are having economic importance in India.
LO3: The students will be familiar with Structural features of rocks and in identifying the faults, folds and Joints.
LO4: They will gain knowledge on ore deposits, petroleum deposits and classification of coals.
LO5: The students will have knowledge on different Ocean floor structures and possibilities of existence of natural gas and petroleum.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO 1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO2**
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	1	1	2	1	-	-	-	-	-	-	-	-	-	2
CO3	3	1	2	-	-	-	-	-	-	-	1	-	1	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	2
CO5	2	2	2	-	-	-	-	-	-	-	-	-	1	1

Solid Earth Geophysics			
M.Sc (Tech) Geophysics- II semester			
Course Category	Basic Science core course	Course Code	GS-202
Course Type	Theory	Lectures-Training-Practical	4-0-0
Prerequisites	Basics of the Mathematics & Physics	Internal Assessment Semester End Examination Total Marks	20 80 100

Course Objectives

Upon completion of this course, the students will acquire and understanding of the following topics:

1. To provide knowledge on basics of Geophysics, and Geothermics.
2. To inculcate knowledge on the seismic waves and earth geomagnetic field.
3. To inculcate the student on the basics on plaeomagnatism.

M.Sc (Tech) Geophysics

II SEMESTER

GS 202: Solid Earth Geophysics

UNIT 1

Introduction to Geophysics: Geophysics and its importance among Earth Sciences. Geophysics: Scope of study of various Geospheres, Interior of the earth, Lithosphere, Asthenosphere, Crust, SIAL, SiMA, Conrad discontinuity, Mantle, Lehmann doscountinuity, Gutenburg discontinuity, Core, Earth's internal divisions and PREM. Crustal structure studies: Composition and structure of upper and lower continental crust, layering in oceanic crust, isostasy, schems of isostasy, reduction procedures, isostatic anomalies, study of isostatic compensation, crustal structure studies.

UNIT II

Geothermics: Basics of Geothermal History Evoluation of the earth as a member of solar system, major sources of Heat inside the Earth since its accretion, role of radioactive heating, distribution of long-lived radioactive elemnts in crustal rocks; thermal history of the Earth, its solidification from molten magma, sinking of iron and formatiom of proto-core; Jacob's hypothesis for liquid nature of the outer core. Geothermal gradient, adiabaic self-compression.

UNIT III

Variation of physical quantities and seismic wave velocity inside the earth, major sub-divisions, Seismic wave propagation inside the earth, variations of density, gravity and pressure, elastic moduli K (bulk), μ (rigidity) and quality factor Q. Petrophysics: Different physical and Engineering properties of rocks Laboratory measurements of the physical properties of rocks namely Density, Seismic wave velocities, Magnetic susceptabililty, Electrical resistivity, thermal conductivity, porosity and permeability.

Unit IV

Earth's magnetic field, Geomagnetic elements, internal and external fields, main fields, and variational field, magnetic and geomagnetic coordinates, measurement and recording of main field, measurement of horizontal, vertical, declination, inclination and total field. Magnetometers and variographs. Theories of the earths main magnetic field, secular variation, dynamo theory of the main field, geomagnetic indices, C_i, C_R, K_s, K_p indices, concepts of quite (Sq) and disturbed (Dst)days, geomagnetic observatories in India, functions, IGRF concept, its role in magneticmethod.

Unit V

Plaeomagnetism: Natural remanantMagnetisation, Measurement of direction and Intensity of NRM. Continental drift and polar wonder curves. Reversals of the magnetic field, polarity of the geomagnetic field, geomagnetic scale, and projective method of presenting palaeomagnetic data, magnetic latitude and co - latitude, calculation of mean direction of virtual geomagnetic poles, palaeomagnetic poles, reconstruction of palaeomagnetic poles, continental drift, northward drift of India, results from differentcontinents.

Books

1. Debate about the Earth, H. takenchi, S. Uyeda and H.Kanamori
2. Fundamentals of Geophysics, WilliamLowrie

3. Geomagnetism, SydneyChapman
4. Application of Palaeomagnetism, E.Erwing
5. Palaeomagnetism and Continents, J D APiper
6. Palaomagnetism and Plate tectonics, M WMcElhimy
7. Introduction of Geophysics,Howell
8 Physics and Geology, Jacobs andRussel
9 Physics of the earth,Stacy
10. The interior of the earth, M.H.P.Bott
11. Topics in Geophysics, P.J.Smith
12. General Climatology, HJ.Critchfield
13. Earth, Press & Siever

Upon the successful completion of the course will provide		**Cognitive Level**
CO1	To provide the importance of Geophysics among earth sciences	Understanding
CO2	To provide the basic knowledge on the geothermal history, evolution of the earth.	Understanding
CO3	To provide the basic physical properties of rocks for understanding the Sub-surface of the earth	Understanding
CO4	To provide the basic knowledge on the theory of the earths magnetic field.	Analysing
CO5	To provide the basic knowledge on reconstruction of paleomaginetic poles.	Analysing

Course Specific Outcome (CSOs)

CSO1 It provides the basic importance of geomagnetic studies.
.

CSO2 It provide the Sub-surface picture by making use of seismic waves

CSO3 To provide the application of paleomaginetic studies to understand the past climate

Learning Outcomes (LOs)

LO1: The students will have a broad understanding on internal structure of the earth..
LO2: The students will gain different theories on evolution of earth.
LO3: The students will be able to understand the various of physical properties for understanding the dynamics of the earth.
LO4: To provide the good knowledge of magnetic elements of the earth and theories on the earth's magnetic field
LO5: They will get knowledge on of paleomaginetic poles and their role in understanding plate tectonics.
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Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	1	1	2	1	-	-	-	-	-	-	-	-	-	2
CO3	3	1	2	-	-	-	-	-	-	-	1	-	1	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	2
CO5	2	2	2	-	-	-	-	-	-	-	-	-	1	1

Remote sensing & GIS			
M.Sc (Tech) Geophysics- II semester			
Course Category	Basic Science core course	Course Code	GS-203
Course Type	Theory	Lectures-Training-Practical	4-0-3
Prerequisites	Basics of the Mathematics & Physics	Internal Assessment Semester End Examination Total Marks	20 80 100

Course Objectives

Upon completion of this course, the students will acquire and understanding of the following topics:

1.To provide basic concepts like different wavelength bands in EM spectrum, active and passive remote sensing system, interaction of EM energy with matter, and different types of scattering

2. To provide the overview of aerial photography, data collection methodology, and its applications. Apart from they will acquire the concept of color theory, its applications

3. To provide the basic concept of thermal remote sensing system, and its applications. And also they will learn about different types of orbits, weather forecasting satellites.

M.Sc (Tech) Geophysics

II SEMESTER

GS 203: Remote sensing & GIS

UNIT-1 Fundamentals of Remote Sensing: Introduction: basic principles of remote sensing; electromagnetic spectrum; Planck's law and wien's displacement law; concept of incoming short wave and outgoing long wave radiation: passive and active remote sensing, interaction of electromagnetic radiation with matter; interaction of electromagnetic radiation with atmosphere; selective and non-selective scattering; impact of scattering on remotely sensed data; atmospheric windows and absorptionbands

UNIT-2 Spectral reflectance properties and Sensors: interaction of electromagnetic radiation with solids and liquids of the earth's surface; spectral reflectance curves of water, snow, clouds, and vegetation. Soils/rocks/minerals. Sensors: imaging and non-imaging sensors: radiometers, spectrometers. Spectroradiometers; Scanner dependent systems: line scan systems, array scanning systems, multispectral scanner systems: whiskbroom and pushbroomimaging systems; circular/conical/side scanning systems: sensor characteristics - spatial resolution, spectral resolution, radiometric resolution and temporalresolution.

UNIT-3 Aerial photography: various types of aerial cameras and black and white films; scale, brightness, contrast of photograph; resolution of photograph - resolving power of film and camera lens; vertical and oblique aerial photographs; methods of aerial photographic surveys; parallax/relief displacement, stereophotography, mirror arid pocket stereoscopes, Photomosaic, low and high sun elevation angle photography. Color theory - primary and secondary colors; additive and subtractive color mixtures to generate colors, color code, working principle of normal and infrared color films and photographs; color composites - true, standard false color and false color composites; application of normal and infra redphotographs.

UNIT-4 Satellite remote sensing: Various platforms used for remote sensing data acquisition; orbits of satellites; geo-synchronous and sun-synchronous orbits; OPTICAL REMOTE SENSING SATELLITES: environmental meteorological satellites (past and present) and their sensors - GOES, Meteosat, INSAT, GMS, NOAA etc.; earth resources observation satellites (past, present and future) and their sensors - NIMB US/coastal zone color scanner, Landsat, Spot, Mos, IRS-la, Ib, Ic, Id, p2, p3, p4, p5, p6 etc. Indian remote sensing activity; future remote sensing missions of ISRO for earthobservation.

UNIT-5 Thermal infrared remote sensing: Thermal processes and properties, radiant flux, heat transfer, atmospheric transmission, thermal properties of materials, thermal infrared signatures of various rocks and minerals, influence of water and vegetation on thermal inertia; thermal infrared sensors

like infrared radiometers, working principle of thermal infrared scanner; TIMS etc.; satellites and sensors acquired and acquiring data under thermal infrared region - HCMM, NOAA-AVHRR, EOS-TERRA, EOS-AQUA, Geostationery satellite sensors etc.; characteristics of thermal infrared images, relative comparison of night and daytime thermal infrared imagery; advantage of thermal infrared remotesensing

UNIT - 5 Geographical information systems (GIS): Introduction: functions of GIS, spatial data bases - position, attributes; data base structures; data base management; geographic data types - vector and raster; introduction to coordinate system and map projections; application of GIS in Hydrology and other earthsciences.

Books :

1. Remote Sensing: Principles and Interpretation, Floyd F. Sabins, IR..W.H.. Freeman & Co., San Francisco, 426p
2. Introduction to the Physics and Techniques of Remote Sensing,CharlesElachi: Johnwiley& Sons p.413
3. Information Booklets form various satelliteagencies
4. Manual of Remote Sensing, Vol. I & Vol. Ed, American Society for photogrammetry and RemoteSensing

Upon the successful completion of the course will provide		**Cognitive Level**
CO1	To provide basic concepts like different wavelength bands in EM spectrum, active and passive remote sensing system, interaction of EM energy with matter, and different types of scattering	Understanding
CO2	To provide basic idea of spectral signatures, and its applications for mapping of natural resources; different types of soils, minerals, etc. And also to give an overview of scanning of data from satellites.	Understanding
CO3	To provide the overview of aerial photography, data collection methodology, and its applications. Apart from they will acquire the concept of color theory, its applications	Understanding
CO4	To provide the basic concept of thermal remote sensing system, and its applications. And also they will learn about different types of orbits, weather forecasting satellites.	Analysing
CO5	To give general overview of GIS, its basic components, data models in GIS, data generation, analysis and its applications	Analysing

Course Specific Outcome (CSOs)

CSO1 Students become familiar with EM spectrum, and applications of Active and Passive remote sensing systems, and also acquire knowledge on interaction of EM radiation with different boundaries and response of EM energy.

CSO2 Student can understand the role of spectral reflection curves, and its applications in the field of earth sciences

CSO3 Students will understand how remote sensing and GIS will useful for generation of different thematic layers, data collection from satellites, analysis and interpretation by making use of GIS.

Learning Outcomes (LOs)

LO1: After the course, students will have broad understanding different wavelength bands in EM spectrum, and its each characteristic (Atmospheric windows and absorption bands). And also they can understand the interaction of EM radiation with matter.
LO2: Students will learn the data collection procedure from Aerial photography.
LO3: Students will learn about different satellites on board, and its applications
LO4: Student will learn the importance of remote sensing to collect data of inaccessible areas
LO5: Students will learn the data creation, analysis, and generation of thematic maps in GIS.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO 1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO2**
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	1	1	2	1	-	-	-	-	-	-	-	-	-	2
CO3	3	1	2	-	-	-	-	-	-	-	1	-	1	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	2
CO5	2	2	2	-	-	-	-	-	-	-	-	-	1	1

Geophysical Signal Processing and Inversion Theory			
M.Sc (Tech) Geophysics- II semester			
Course Category	Basic Science core course	Course Code	GS-204
Course Type	Theory	Lectures-Training-Practical	4-0-3
Prerequisites	Basics of the Mathematics & Physics	Internal Assessment Semester End Examination Total Marks	20 80 100

Course Objectives

Upon completion of this course, the students will acquire and understanding of the following topics:

1.To provide the basic knowledge on the signal and noise.

2.To provide knowledge on FFT and DFT

3.To provide knowledge on the band limited signals, digital faltering and inversion theory.

M.Sc (Tech) Geophysics

II SEMESTER

GS 204: Geophysical Signal Processing and Inversion Theory

UnitI Introduction, Definition of signal and noise, various signal classes such as continuous, piece wise continuous, absolute integrable, singularity, unit impulse, unit step, etc. Fourier series and Fourier Transform: Time and frequency domain, relations between various operations in both the domain, Fourier Transform and its properties, FFT, Rectangular, exponential functions, singularity functions and periodic functions. Helbert transform, Walshtransformation

UnitII Time-series analysis: Discrete time signals, Correlation and convolution functions, impulse response and Transfer function spectrum of observational data: Discrete Fourier Transform (DFT), Z-Transforms, Delay properties ofwavelets.

UnitIII Band limited signals: Properties, Sampling Theorem, Nyquist frequency, Aliasing, Sampling of band and time limited signals; Effect of sampling on spectrum and vice-versa; reproduction of continuous function from sampled data. Importance and effects of Windowing, Gibbs phenomenon, spectral leakage, various types of windows; hanning windows, power spectrum; Estimation of power spectrum, use of various windows in power spectrum computation, spectrum computation via Auto-correlation and Periodogram. Moving average method, maximum entropy method, maximum likelihood method, auto regressionmethod.

UnitIV Digital filtering: Design of digital filters, amplitude and phase response of various filters; one-sided and two sided filters, low-pass, high pass and band-pass, optimum filters, Butter worth filter, Recursive and non-recursive filters, optimal and Weiner filters, Deconvolution and predictivedeconvolution.

Unit-V Inversion Theory: Introduction, Fundamentals of Inversion, Linear Inversion,Non-Linear Inversion, Incorporating prior information, Parametric Inversion, Assessingthe uncertainty in inverted models.

Books:

1. Spectral analysis in Geophysics, MarkusBath

2. Theory and application of digital signal processing, Rabiner,L.R and Gold,B.

3. Digital signal processing and time seriesanalysis,Enders A.Robinson
4. Statistical theory of communication,Y.W.Lee
5. Analysis of Geophysical Potential Fields, P.S.Naidu&M.P.Mathew
6. Seismic Filtering, Nathan Rothenburg, SEGpublication
7. Time sequence analysis in Geophysics,E.R.Kanasewich
8. Signal Analysis,B.P.Lathy
9. Inverse problem theory,Tarantola.A,1987
10.Solutions of ill-posed problems, Tikhonov.A.V, and Arsenin.V.Y, 1977
11.Computational methods for Inverse problems, Vogel.C.R,2001

Upon the successful completion of the course will provide		**Cognitive Level**
CO1	To educate the student on different types of signals	Understanding
CO2	To educate the student on wavelets and discrete time signals	Understanding
CO3	To educate the student on the sampling theorem various types of windows and spectrum computation	Understanding
CO4	To educate the student with the basic concepts of digital filtering.	Analysing
CO5	To educate the student on fundamental of inversion	Analysing

Course Specific Outcome (CSOs)

CSO1 The students can understand the geophysical signal processing and inversion theory.

CSO2 The students will be acquainted knowledge on the usage of FFT, Moving average methods and MEM.

CSO3 The students can understand the optimum filters and uncertainty in inverted model's.

Learning Outcomes (LOs)

LO1: After the course the students will have a broad understand on the signal and noise and usage of FFT.
LO2: The students will have an understanding on time series analysis, DFT, wavelets and jet transforms.
LO3: The students will be acquainted with the band limited signals, Aliasing and sampling theorem and various spectrum computation techniques.
LO4: The students can understand the Digital filtering and optimum filters.
LO5: The students can learn the fundamentals of linear and Non-linear inversions.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO 1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO2**
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	1	1	2	1	-	-	-	-	-	-	-	-	-	2
CO3	3	1	2	-	-	-	-	-	-	-	1	-	1	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	2
CO5	2	2	2	-	-	-	-	-	-	-	-	-	1	1

Gravity Method			
M.Sc (Tech) Geophysics- III semester			
Course Category	Basic Science core course	Course Code	GS-301
Course Type	Theory	Lectures-Training-Practical	4-0-3
Prerequisites	Basics of the Mathematics & Physics	Internal Assessment Semester End Examination Total Marks	20 80 100

Course Objectives

Upon completion of this course, the students will acquire and understanding of the following topics:

1. To provide the knowledge of the theories and concepts related to the gravity prospecting instruments and their operation.
2. To provide the knowledge acquire, interpret gravity data.
3. To provide the Earth's gravity concepts, figure of the earth, isostatic equilibrium, Geoid, Spheroid. Etc.

M.Sc (Tech) Geophysics

III SEMESTER

GS 301: Gravity Method

(Common paper with MGS 301 Gravity method in M.Sc Marine Geophysics)

UnitI Earth's Gravity field, Properties of Newtonian potential, Laplace's and Poissons's equations, Green's theorem, Gauss law, continuation integral, equivalent stratum, spatial and temporal variations, Principle of gravity prospecting, concept of gravity anomaly. Rock densities, factors controlling rock densities, Bouguer density, Insitu determinations, Borehole methods. Gravity prospecting instruments – Static gravimeters, Astatization, Zero-length spring, Worden & Lacoste Romberg Gravimeters.

UnitII Plan of Gravity surveys – mineral exploration, oil prospecting and Geological mapping, Establishment of gravity base net work, Reduction of gravity data. Airborne and shipborne gravimetry, horizontal and vertical accelerations, Eotvos correction. Regional and residual separation – graphical, average, grid and curve fitting methods, reliability of different types of residuals. Ambiguity in gravity interpretation

UnitIII Interpretation of gravity data – Qualitative interpretation, identification of structural features and litho contacts, two-dimensional and three-dimensional bodies - nature of anomalies. use of filters, vertical derivative calculations, upward and downward continuation of anomalies, classical methods using continuation integral, harmonic analysis and Fourier Transformation. Mass estimation ingravity.

UnitIV Classical method of interpretation, gravity anomalies of point and line masses, circular discs, vertical cylinders, sheets, faults and rectangular slabs, Characterstics of anomalies, interpretation by simple thumb rules and characteristic curves. Forward modeling of gravity anomalies of two-dimensional and three-dimensional bodies of arbitrary shape, Graticules, computer models, anomalies of two-and-half-dimensionalbodies.

UnitV Inversion of gravity anomalies of 2-D polygonal bodies, Automatic gravity modeling of sedimentary basins and density interfaces by Bott's method. Modeling of gravity anomalies using linear, exponential and quadratic density contrast. Use of Fourier Transforms in Gravity interpretation, Spectral depths, Application of gravity methods for regional geological mapping, Oil exploration – salt domes, structural traps, mineral

exploration – sulphide ores, ferrous and non-ferrous ores, diamonds, placer deposits, groundwater and Engineeringproblems.

Books:

1. The Earth and its gravity field, A.A.Heiskanen and F.AVening
2. Gravity and magnetics in oil prospecting,L.L.Nettleton
3. Gravity and magnetic methods, Rao, B.S.R and Murthy,I.V.R
4. Gravity and magnetic Interpretation in ExplorationGeophysics, I.V.Radhakrishna Murthy
5. Marine Gravity, PeterDenelinagar
6. Applied Geophysics, W.W.Telford et.al
7. Introduction to Geophysical prospecting,M.B.Dobrin
8. Interpretation theory in Applied Geophysics, F.S.Grant andWest.

Upon the successful completion of the course will provide		**Cognitive Level**
CO1	Students will learn the fundamental concepts of Earth's gravity field..	Understanding
CO2	They acquire knowledge of the theories and concepts related to the gravity prospecting instruments and their operation.	Understanding
CO3	Students will acquire how to conduct field survey, data acquisition and reduction.	Understanding
CO4	Sound knowledge of interpretin gravity data using different curves & software.	Analysing
CO5	Will learn the application of gravity method in finding different geological structures.	Analysing

COURSE SPECIFIC OUTCOMES (CSOs)

CSO1 : Students will acquire sound knowledge of Earth's gravity concepts, figure of the earth, isostatic equilibrium, Geoid, Spheroid.
CSO2 : They will be able to analyze the different directions to acquire, interpret gravity data.
CSO3 : Students will learn how to apply these methods to different field data.

LEARNING OUTCOMES (LOs)

LO1 : Students will be able to thoroughly understand the fundamental concepts of Earth's gravity field, potential and their formulae.
LO2 : Students will be able to learn different gravimeters and their calibration and their use.
LO3 : They will learn how to apply geophysical techniques to analyse the contours and profiles and to apply for deleaniationof oil bearing structures and mineral exploration.
LO4 : Students will learn about modeling and inversion in space and frequency domain.
LO5 : Students will be able to apply the gravity method for finding the structure of a sedimentary basin.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2
CO1	2	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	3	2	3	2	-	-	-	-	-	-	-	-	-	3
CO3	2	3	2	-	-	-	-	-	-	-	-	-	2	2
CO4	3	2	2	-	-	-	-	-	-	-	-	-	2	3
CO5	3	3	2	2	-	-	-	-	-	-	-	-	1	3

Electrical Methods of Exploration			
M.Sc (Tech) Geophysics- III semester			
Course Category	Basic Science core course	Course Code	GS-302
Course Type	Theory	Lectures-Training-Practical	4-0-3
Prerequisites	Basics of the Mathematics & Physics	Internal Assessment Semester End Examination Total Marks	20 80 100

Course Objectives

Upon completion of this course, the students will acquire and understanding of the following topics:

1. To provide the knowledge in understanding the factors affecting the resistivyt and maurement of resistivity.
2. To provide different arrays in resistivsity method, and also an over view of the SP, and IP methods of data collection, processing
3. To provide the interpretational techniques both manual and computer.

M.Sc (Tech) Geophysics

III SEMESTER

GS 302 - Electrical Methods of Exploration

Unit – I

Principles of Geo-Electrical Methods of Prospecting; Pole-Dipole Sources – distribution of equi-potential lines; Electrical properties of Rocks and Minerals – Laboratory Measurements. Factors effecting resistivity of Rocks; Archie's law; Isotropy and Anisotropy; Principle of Equivalence and Suppression; Darzarroukparameters.

Unit – II

Origin of Self-potentials; Behaviour and Measurements of SP Anomalies; Interpretation of SP anomalies over different geometric bodies; Concept of Apparent Resistivity; Apparent Resistivity over multilayered Earth; Concepts of Sounding and profiling; Different Types of electrode arrays: Werner, Schlumberger, Dipole, Dipole-Dipole, two-electrode and three electrode configurations etc.;

Unit – III

Geometric Factors and Apparent Resistivity of different configurations; Principle of reciprocity. Computation of Apparent Resistivity Model Curves – Image Theory – Numerical Integration – Linear Filter Theory; Transformation of Vertical Electrical Sounding Curves from Werner to Schlumberger and vice-versa;

Unit – IV

Reflection coefficient; Kernel, Bessel and Resistivity Transformation Functions and their relation to Apparent resistivity; Interpretation of Resistivity Data – Direct & Indirect Methods – Application of Linear and Filter Theory and Iterative methods.

Unit – V

Concepts and Principles of Induced Polarisation- Over Voltage and Induced Polarisation– Warburg Impedance. Time Domain and Frequency Domain methods – Concepts and Measurements; Percentage Frequency Effect, Metal Factor etc – Brief principles and applications of Spectral IP and Magnetic

Induced Polarisation.

Books:

1. Applied Geophysics, W.M. Telfordet.al.
2. Electrical Methods in geophysical prospecting by GeorgeV.Keller
3. D.C Geo electric sounding by P.K.Bhattacharya andH.P.Patra
4. Geo sounding Principles, Vol 1 byO.Koefoed
5. Interpretation of resistivity data, by Robert G.VanNorstrandand Kunneth L. Cook: USGS professional paper,499
6. Principles of Induced Polarization for geophysical exploration, J.S.Summer

Upon the successful completion of the course will provide		**Cognitive Level**
CO1	Provide the knowledge of electrical properties of rocks and minerals, factors affecting the resistivity of rocks and minerals.	Understanding
CO2	Provide the over view of SP method (data collection, processing and interpretation), concept of apparent resistivity, different electrode configurations for resistivity data collection..	Understanding
CO3	Proved the knowledge on geometric factor for different arrays, knowledge on computation of resistivity data model curves, the concept of transformation techniques.	Understanding
CO4	Provide the knowledge of interpretation of resistivity data.	Understanding
CO5	The over view of IP method (principles, data collection, interpretion)	Understanding

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Course Specific Outcomes (CSOs)

1. To understand the basic concepts of electrical resistivity method
2. To provide the knowledge of earth subsurface resistivity model curves
3. To provide the knowledge of interpretation of electrical resistivity data
4. To provide the application of electrical resistivity data for groundwater, mining and environmental solutions.

Course Learning Outcomes (CLOs)

1. Students will gain knowledge on the concepts of electrical properties of rocks.
2. Students acquire knowledge on the rock water interaction, factors affecting the resistivity of rocks.
3. Students learn the laboratory and field procedure of electrical resistivity measurements.
4. Students will acquire knowledge on resistivity data processing and interpretation using manual and softwares .
5. Students can able to understand the impact transformation of resistivity data from one array to another array, to get better resolution of data.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO 1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO2**
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	1	1	2	1	-	-	-	-	-	-	-	-	-	2
CO3	3	1	2	-	-	-	-	-	-	-	1	-	1	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	2
CO5	2	2	2	-	-	-	-	-	-	-	-	-	1	1

Seismic Prospecting Common syllabus for M.Sc. (Tech) Geophysics - III semester			
Course Category	Basic Science core course	Course Code	GS 303
Course Type	Theory	Lectures-Training-Practical	4-0-3
Prerequisites	Basics of the Physics and Mathematics and Geology	Internal Assessment Semester End Examination Total Marks	20 80 100

Course Objectives

Upon completion of this course, the students will acquire an understanding of the following topics:

1. Basic seismic principles: Fermat's Principle. Generalized Snell's law. Reflection,refraction and diffraction from multilayered media. Reflection and transmissioncoefficients,Zoeppritz'sequation.Propagationmodelforexplorationseismology.
2. Seismic Methods/Analysis: Seismic energy sources, Seismic noises and NoiseProfile Analysis, Source and receiver arrays, Directional shooting, Shootinggeometry. Instrumentationinrefraction&reflectionsurveys.Digitalseismicdatarecording.
3. Seismic multichannel, seismic survey on land and offshore with 2D & 3D shooting procedure, seismic reflection survey and refraction survey field procedures.

M. Sc. (Tech) Geophysics
GS 303:Seismic Prospecting
(Common paper with MGS 303 Seismic Prospecting in M Sc Marine Geophysics)

Unit –I Principles of elasticity: Normal strains, shearing strains, Hook's law, Elastic moduli, wave equations, Huygen's& Fermat's Principles, Zeoppritz equations, refraction, reflection, critical refraction, diffraction, attenuation & absorption of seismic waves, acoustic impedance, surface waves, dispersion multiples, reflection and transmission coefficients.

Unit- II Elastic wave velocities of rocks: laboratory and field measurements, dynamic moduli, P and S-wave velocities, anisotropy, attenuation, factors affecting velocity, different types of velocities, geometry of ray paths, refraction and reflection, horizontal layers and dipping layers, NMO and dip move out, discrete and continuous velocity changes, velocity inversion, low velocity layer, blind zone, hidden layer.

Unit-III Electromagnetic geophone and its performance, damping coefficient, hydrophones, detector arrays, array response, uniform arrays, amplitude weighted arrays, distance tapered arrays, streamer, analog data acquisition, amplifiers, filters, gain control and recording types. Seismic energy sources for land and marine surveys. Dynamite thumper, dinosies, vibrosies, land air gun, pinger, boomer, sparker, airgun, water gun, vaporchoc etc. Controlled explosions, shot control, source arrays, energy content, frequency, pulse length and resolution, penetration, signatures of energy sources.

Unit-IV Digital data acquisition, digital field system, signal flow and recording. Constituent units and modules. Telemetry systems, wireline and radio telemetry, telemetry system configuration and specifications, dynamic range of signals noise: shot generation, ambient and electrical noises, their nature and attenuation requirements. Noise survey, noise analysis, fold back experiment, optimization of parameters.

Unit-V

Single channel and multi channel surveys, field layouts and shooting procedures for land and marine 2D surveys, split spread and end-on spreads, CDP procedures for land and marine surveys, stacking chart. 3D surveys, 3D layouts, swath, brick, odds & evens, zig zag, button patch, full range 3D, loop survey. Marine 3D shooting: two streamer system, alternate shooting, two boat operation, circles shooting, 3D bottom cable survey, quad quad 3D, multiple streamers, static binning and dynamite binning. Refraction surveys: Field procedures, fan shooting, broad side shooting, inline profiling, long refraction profiles, reversed and unreversed profiles, marine refraction surveys, sonobuoy surveys.
(VSP, shear wave data acquisition and other special surveys procedures are included in paper II along with processing and interpretation of seismic data)

Books: 1. Introduction to geophysical prospecting, M.B.Dobrin.
2. Applied Geophysics, W.M.Telford et. al.
3. Exploration seismology, Sheriff. R.E.
4. Seismic exploration fundamentals, J.A.Coffeen.
5. A hand book for seismic data acquisition, Brain J Evans
6. Designing seismic surveys in two and three dimensions, Dale G Stone

COs	**Upon successful completion of the course, the student will be able to:**	Cognitive level
CO1	Understand the fundamentals of Fermat's principle and Huygens principle and the wave propagation.	Understanding
CO2	Understanding of the wave theory and velocities of the subsurface	Understanding
CO3	Knowledge imparts the seismic source, receiver and seismic recording on land and marine.	Knowledge
CO4	The student has demonstrated competence in scientific ethics and the ability to work independently and as part of a team	Knowledge
CO5	Reflection survey in 2D and 3D on land and marine	Understanding

Course Specific Outcomes (CSOs)

1. The student can carry out basic operation in time series analysis and digital signal processing: compute frequency, phase and time shift of a sinusoid; convolve and correlate two-time signals; apply the sampling theorem.
2. The student can compute ray paths, travel times and amplitudes of seismic waves propagating in simple layered media, and assess the resolving power of these waves as a function of their dominant frequency.
3. The student can carry out velocity analysis on simple CMP gathers.
4. The student is able to plan simple and efficient surveys combining various seismic techniques.

Course Learning Outcomes (CLOs)

The student is expected to understand and apply the follow concepts:

1. Generalized Snell'sandits application to reflection and refraction studies.
2. Reflection survey design ,data collection ,data processing, and analysis.
3. Refraction survey design, data collection, data processing ,and analysis.
4. Geological interpretation of reflection and refraction seismic data.
5. Structural interpretation of seismic data

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	1	1	2	1	-	-	-	-	-	-	-	-	-	2
CO3	3	1	2	-	-	-	-	-	-	-	1	-	1	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	3
CO5	2	2	2	-	-	-	-	-	-	-	-	-	1	3

WELL LOGGING & RESERVOIR ANALYSIS			
M.Sc (Tech) Geophysics- III semester			
Course Category	Basic Science core course	Course Code	GS-304
Course Type	Theory	Lectures-Training-Practical	4-0-3
Prerequisites	Basics of the Mathematics & Physics	Internal Assessment Semester End Examination Total Marks	20 80 100
	G		

Course Objectives

Upon completion of this course, the students will acquire and understanding of the following topics:

1. To provide basic concepts of Reservoir rocks and their petro physical properties, Borehole environment, and Classification of well
2. To provide different logs, and their importance in measuring the physical properties of lithology.
3. To provide the knowledge on reading of well logs, processing, and interpretation of well log data.

3

04: WELL LOGGING & RESERVOIR ANALYSIS

(Common paper with MGS 304 Well logging & reservoir analysis in M Sc Marine Geophysics)

Unit 1: Basic concepts and objectives of well logging. Reservoir rocks and their petro physical properties, Reservoir Thickness, effective, pay and net thicknesses Permeability-Porosity relations, Formation resistivity factor (FR); relation between FR and water saturation. Need of drilling fluid and its properties. Borehole environment, invasion effect and invasion profile. Classification of well logging tools, well logging unit and logging setup. Reservoir geometry, temperature and pressure. Log header, depth scale, depth of investigation and vertical resolution.

Unit II: Electrical logging: SP Log-Origin and occurrence of Self Potential.PSP &SSP, Determination of water salinity and shale volume from Sp log; Resistvity in well logging**:** factors affecting the resistivity of electrolyte bearing rocks, Unfocussed Resistivity Devices- single-electrode, normal and lateral resistivity tools and their limitations; Focused Resistivity Devices- principle of measurement, LL3, LL7 and dual laterologs, factors influencing resistivity measurements. Microresistivity measurements- Micro normal, micro lateral, Micro spherically focussed logs applications and limitations; Induction Resistivity Measurements-principle, two-coil induction tool and its geometric factor, focusing of two coil sonde, skin effect.

UNIT III: Porosity Logs-Acoustic Log: Principles; factors affecting acoustic wave velocity; single and double receiver type tools; borehole compensated systems; cycle skipping; porosity evaluation; overpressure identification; seismic applications. Density Log: Interaction of gamma rays with matter; principle of density log; energy requirements of gamma ray sources for density log; measurement tools- single and double detector type; litho-density log; Neutron Log: Interaction of neutrons with matter, neutron sources and neutron detectors, neutron logging tools, sidewall-neutron porosity probes.

Unit-IV: Radioactive logs- Radioactivity of shales and clays; simple and spectral gamma ray tool including radiation detectors; calibration; factors affecting log response, qualitative and quantitative uses of simple and spectral gamma ray log; Miscellaneous tools: Logging While Drilling (LWD), Dipmeter, caliper log and its variants, side wall coring tool, Casing Collar Locator/casing Inspection tools, Repeat formation tester, Modular dynamic tester, CBL/VDL, NMR log, Micro Imaging tools.

Unit-V: Formation_Evaluation: Cross plots, M-N plots. Determination of water saturation (SW)of clean formations, Quick look interpretation and detailed interpretation of Clean sands and Shaly sands, Identification of Hydrocarbon zones. Application of well logging in ground water, ore mineral and Hydrocarbon exploration; Production logging: Flow in Vertical

Pipes, Flow Types, Reynolds Number, Perforations, Water Holdup, Water Cut, Slippage Velocity, Production Logs: Temperature Log, Flow meters, different types ofFlow meters, Gradiomanometer, Radioactive tracer logs. Noise logging, Well problems- their diagnosis with different Production Logs, Injection Wells, Interpretation of Flow meter & Temperature logs in Injection/Production wells;Production logging in Horizontal Wells (in brief)

Books:

1. Formation Evaluation- E JLynch
2. Induction Logging-Plusynin.
3. Log Interpretation Principles and Charts-Schlumberger
4. Schlumberger Documents,
5. Development and Exploitation of Oils and Gas Fields -Murovyer andAndiasevrentnal
6. Handbook of Well Log Analysis -S JPeterson.
7. Fundamentals of Well Logging Interpretation-O-Serra-Elsevier1984
8. The Geological Interpretation of Well Logs-Malcolm Rder-Rider French Consulting Ltd.2002.
9. Basic Well logging Analysis-By George Asquith &D.Krygowski-The American Association of Petroleum Geologists,2004.

Upon the successful completion of the course will provide		Cognitive Level
CO1	Provide the knowledge of Basic concepts and objectives of well logging, Reservoir rocks and their petro physical properties, and Classification of well logging tools, well logging unit and logging setup.	Understanding
CO2	Provide the over view of Electrical logging, factors influencing resistivity measurements.	Understanding
CO3	Proved the knowledge of Porosity Logs-Acoustic Log. Density Log, and Neutron Log	Understanding
CO4	Provide the knowledge of Radioactive logs, Miscellaneous tools, Logging While Drilling (LWD), and Inspection tools.	Understanding
CO5	Formation Evaluation, Determination of water saturation (SW)of clean formations. Identification of Hydrocarbon zones, and Production logging	Understanding

Course Specific Outcomes (CSOs)

1. To understand the basic concepts of Well logging method
2. To provide the knowledge of different logs that are used to measure the response of subsurface lithodlogy.
3. To provide the knowledge of interpretation of Well-log data
4. To provide the application of different well-logs.

Co.urse Learning Outcomes (CLOs)

1. Students will gain knowledge on the concepts of objectives of well-logging.
2. Students acquire knowledge on the sources and the reservoir rock characteristics
3. Students learn the about different logs, and their measurements.
4. Students will acquire knowledge of interpretation of Well log data .
5. Students can able to understand the responses of different well logs in different subsurface lithologies.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	1	1	2	1	-	-	-	-	-	-	-	-	-	2
CO3	3	1	2	-	-	-	-	-	-	-	1	-	1	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	2
CO5	2	2	2	-	-	-	-	-	-	-	-	-	1	1

Magnetic Method			
M.Sc (Tech) Geophysics- III semester			
Course Category	Basic Science core course	Course Code	GS-401
Course Type	Theory	Lectures-Training-Practical	4-0-3
Prerequisites	Basics of the Mathematics & Physics	Internal Assessment Semester End Examination Total Marks	20 80 100

Course Objectives

Uponcompletionofthiscourse,thestudentswillacquireand understandingofthefollowing topics:

1. To provide basic concepts of Earth's main magnetic field, Coulombs law of magnetic force and fields, magnetic moments, intensity of magnetization and induction, magnetic potential and its relation to field.
2. To provide the knowledge of magnetic data collection using different types of Magnetometers, and its working principles.
3. To provide the knowledge of processing of magnetic data, and interpretation techniques.

GS 401: Magnetic Method

(Common paper with MGS 401Magnetic Method in M Sc Marine Geophysics)

UNITI Earth's main magnetic field, origin and temporal variations (outlines only), Geomagnetic elements, Vectorial representation, spatial variation, Basic concepts, Coulombs law of magnetic force and fields, magnetic moments, intensity of magnetization and induction, magnetic potential and its relation to field, units of measurement, origin of magnetic anomalies, interrelationship between different component anomalies, Poisson's relation, Magnetic susceptibility, factors controlling susceptibility, magnetic classification of minerals and rocks, Laboratory and in-situ methods of determining susceptibility, Natural remanent magnetism, Astatic and Spinner Magnetometers, demagnetizationeffects,

UNITII Principle of magnetic prospecting, Instruments - Nuclear, fluxgate, Squid's and optical pumping magnetometers, gradient measurements, Plan of magnetic surveys in different mineral exploration programs, Magnetic data reduction, diurnal and normal corrections, IGRF, Airborne magnetometry, orientation mechanisms, survey techniques, data acquisition and reduction, Advantages and disadvantages, brief principles of ship-borne and satellitemagnetometry

UNIT III Interpretation of magnetic data, qualitative interpretation, nature of anomalies, identification of different structural features. – Dependence of magnetic anomalies on latitude and orientation. Isolation and enhancement of anomalies using graphical, trend surface analysis, digital filtering, reduction to pole filter, derivative and continuation filters (Brief descriptions), Ambiguity in magnetic interpretation, generalized approach of interpretation.

UNIT IV Magnetic anomalies (vertical and total field) of single poles and sphere, anomaly equations, profiles, properties and interpretation procedures. Similarity of magnetic anomalies of two dimensional bodies in different components – generalized equations for the magnetic anomalies of line dipoles, dykes, sheets and faults, profile shapes and interpretation by thumb rules and characteristic curves, ambiguity in interpretation of magnetized dyke, Koloumzine method, Forward modelling of magnetic anomalies: Gulatee's rule, two dimensional and three-dimensional bodies of arbitrary shape, use of graticules, Computer models, familiarization of anomalyequations,

UNIT V Principles of inversion, Inversion of magnetic anomalies of 2D polygonal bodies, magnetic anomalies of dykes and magnetic interfaces - Frequency domain interpretation: Use of Fourier transforms in magnetic interpretation with special reference to dykes and faults, end corrections, use of Hilbert transforms, Relation figures, Spectral depth estimates; MAGSAT anomalies- Application of magnetic method for regional geological mapping, oil exploration, mineral exploration, ground water and Engineeringproblems.

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 ExplorationGeophysics, I.V.Radhakrishna Murthy
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 andWest
7. Special issue on Geomagnetic methods and Lithosphericstructure, Proc. Of Earth and Planetary Sciences, Indian Academy of Sciences,Vol.99(4),1990

Upon the successful completion of the course will provide		**Cognitive Level**
CO1	The course provides the knowledge of the Earth's main magnetic field, its variation.	Understanding
CO2	The course gives immense knowledge about different magnetic instruments and their operation.	Understanding
CO3	The course provides insights into the Geomagnetism and Palaeomagnetism and their application.	Understanding
CO4	The course provides knowledge of deleanating the structures related to oil bearing and mineral and regional geology.	Analysing
CO5	The course provides knowledge on the principal's of inversion	Analysing

COURSE SPECIFIC OUTCOMES (CSOs).

CSO1 : The student will learn about the magnetic field of the Earth and upper atmosphere.
CSO2 : Students will learn about the magnetic elements and their relation, day to day and long term variation of the Earth's field.
CSO3 : Students will learn about the magnetic field survey, data acquisition and interpretation techniques.
CSO4 : Students will learn about the application of magnetic method for modeling and inversion of magnetic data.

LEARNING OUTCOMES (LOs)

LO1 : Students will be able to analyse the Earth's magnetic field and its variation from place to place.
LO2 : They will be able to understand and analyse the short term and long term variations of Earth's magnetic field
LO3 : They will be able to learn the magnetic survey procedures and interpretation of software procedures including IGRF.
LO4 : The students will be able to comprehend the idea of present Earth's magnetic field and ancient magnetic field.
LO5 : The students will be able to understand the regional geological mapping, oil exploration and mineral exploration

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	1	1	2	2	-	-	-	-	-	-	-	-	-	2
CO3	3	2	3	-	-	-	-	-	-	-	-	-	2	3
CO4	2	2	2	-	-	-	-	-	-	-	-	-	2	3
CO5	2	3	2	-	-	-	-	-	-	-	-	-	1	3

ELECTROMAGNETIC METHODS OF EXPLORATION			
M.Sc (Tech) Geophysics- III semester			
Course Category	Basic Science core course	Course Code	GS-402
Course Type	Theory	Lectures-Training-Practical	4-0-3
Prerequisites	Basics of the Mathematics & Physics	Internal Assessment Semester End Examination Total Marks	20 80 100

Course Objectives

Upon completion of this course,the students will acquire and understanding of the following topics:

1. To inculcate knowledge on basicprinciples of EM methods of exploration.
2. To provide the knowledge of field data collection methods, procedure, processing of data
3. To impart knowledge of application of EM data to solve various geological and geophysical problems

402GS 402: ELECTROMAGNETIC METHODS OF EXPLORATION

UNITI *Basics*: Electromagnetic Induction, Primary-Secondary field relations, Vector Diagram-Real and Imaginary components. Response function, Elliptic polarization, Maxwell's equations, Boundary conditions, Wave equation, Quasi static condition, Solution of wave equation, Plane wave characteristics, propagation of plane waves in conducting media, Wave number, Skin depth, Impedance, factors controlling depth penetration in EM; *Classification of E.M. methods*: Sources used, continuous wave and pulse excitation principles, Measured components. Brief principles of solving electrodynamic problems including scalemodeling.

UnitII Field of large loop, magnetic dipole and electric dipole in air – frequency and Time domain approaches. Field of magnetic dipole and electric dipole (both in transient and frequency domains) in homogeneous, isotropic space. Response of stratified medium to the above sources. Frequency and transient response of local conductors in homogeneous field –Sphere and Cylinder. Effect of frequency and magnetic permeability on the secondary fields – Sphere as an example, Generalized induction parameter. Effect of overburden and Host rock on E.M.response.

Unit III Methods using artificial fields: Surface low frequency methods: Principles, field procedures and various corrections, quantitative interpretation in Turam, Tilt angle and Slingram methods, Operation at low induction numbers - terrain conductivity measurements. Surface transient methods: Principles, Comparision with harmonic methods, Description of different current functions, various T-R configurations, General field procedures, Interpretation of surface transient EM data. Principles of EM soundings, Field procedures, Geometric versus parametric sounding, data preparation, interpretation and applications. Radio wave methods: Principles,VLF EM/EMR methods, Interpretation of VLF EMR data; Ground Penetrating Radar and itsapplications.

Unit IV Methods using natural fields: Principle of MT, Origin of Earth's natural EM field:

Magneto-telluric source field characteristics, MT field procedure and instrumentation. Cagniard's relation, Impedance over N-layer medium. Apparent resistivity and phase, MT tensor. MT Signal Processing. Swifts optimum rotation, Skew, Tipper, Ellipticity, Coherency, Static shift, remote reference magnetotellurics, Induction arrows, Polar diagrams, 1-D, 2-D interpretation of magnetotelluric data – Applications. Brief Principles of AMT, Controlled Source Audio Magnetotellurics(CSAMT) and AFMAG. Telluric current method, Field and Interpretationprocedures.

UnitV

Airborne EM methods: Different systems in operation, Continuous wave and transient (INPUT) systems, Rigid Boom Helicopter System, passive Airborne EM systems – AFMAG and VLF, Different noises in AEM systems and methods of suppression, interpretation of AEM data and applications. Geomagnetic depth soundings: Origin and classification of long period geomagnetic Variations, separation of magnetic field of internal and external origin, normal and anomalous fields. Interpretation of Geomagnetic depth sounding data, Magnetometer arraystudies.

Contd.,

Books:

1. Interpretation theory in Applied Geophysics, Grant andWest
2. Applied Geophysics, Telford, et. al., revisededition
3. Mining Geophysics, Vols. 1 & 2 – SEGpublications
4. Electrical methods of Geophysical Prospecting, Keller andFrischknecht
5. Geosounding Principles Vol. II, Patra andMallick
6. Magnetotelluric method, Keller andKaufman
7. Mining Geophysics,Parasnis
8. Introduction to Geophysical Exploration, Kearey andBrooks
9. EM methods in Applied Geophysics, Vols.I&II, Nabighian, M.N ed, SEGPublications
10. Deep Electromagnetic Exploration, K.K.Roy, S.K.Verma and K.Mallick (eds), NarosaPublishing House,1999.
11. The Geolelectrical methods in Geophysical Exploration, M.S.Zhdanovand G.V.Keller, Elseiver,1990
12. Electrical methods in Geophysical Exploration of Deep sedimentary basins, S.H.Yungul

Upon the successful completion of the course will provide		**Cognitive Level**
CO1	To provide basic concepts of electromagnetic induction and classification of EM methods.	Understanding
CO2	To provide knowledge on the magnetic dipole and electric dipole in air	Understanding
CO3	To provide the basic knowledge on the surface low frequency methods and applications of ground penetrating RADAR.	Understanding
CO4	To provide the knowledge on the earth's natural EM Field.	Analysing
CO5	To impart knowledge on air born EM Methods.	Analysing

Course Specific Outcome (CSOs)

CSO1 The students become familiar with the basic concepts of electro magnetic induction and principals of solving electrodynamic problems

.

CSO2 The students become familiar with the Field of magnetic dipole and electric dipole in transient and frequency domains and principles of EM soundings

CSO3 The students will be familiar with polar diagrams and passive Airborne EM systems

Learning Outcomes (LOs)

LO1: The students will have broad understanding on wave equations and classification of EM methods.
LO2: The students will be acquainted with frequency and transient response of local conductor's
LO3: The students will be familiar on the interpretation of surface transient EM data
LO4: The students will be acquainted with the application of polar diagrams and 1-D and 2-D Interpretation of magnetotelluric data
LO5: The students will be familiar with Airborne EM methods and Geomagnetic depth soundings

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO 1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO1 0**	**PO1 1**	**PO1 2**	**PSO 1**	**PSO2**
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	1	1	2	1	-	-	-	-	-	-	-	-	-	2
CO3	3	1	2	-	-	-	-	-	-	-	1	-	1	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	2
CO5	2	2	2	-	-	-	-	-	-	-	-	-	1	1

Seismic Data Processing and Seismic Stratigraphy Common syllabus for M.Sc. (Tech) Geophysics - IV semester			
Course Category	Basic Science core course	Course Code	GS 403
Course Type	Theory	Lectures-Training-Practical	4-0-3
Prerequisites	Basic knowledge of math and physics	Internal Assessment Semester End Examination Total Marks	20 80 100

GS-403: Seismic data processing and Seismic Stratigraphy

(Common paper with MGS 403 Seismic data processing and Seismic Stratigraphy in M Sc Marine Geophysics)

Course Objectives

Uponcompletionofthiscourse,thestudentswillacquireanunderstandingofthefollowing topics:

1. Basic interpretation method of seismic refraction data, delay time method and Plus-minus time method, finally understanding the Generalized Reciprocal Method.

2. Seismic Reflection Method/Analysis: Basic seismic data processing and general flow of the seismic data processing.
3. Seismic reflection method for oil & gas exploration, groundwater exploration and coal exploration.
4. Hydrocarbon indicators and AVO analysis.
5. Seismic stratigraphic section for geological interpretation with seismic data

M. Sc. (Tech) Geophysics
GS-403: Seismic data processing and Seismic Stratigraphy
(Common paper with MGS 403 Seismic data processing and Seismic Stratigraphy in M Sc Marine Geophysics)

Unit –I 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, reduction and interpretation of sonobuoy data, crustal seismology, engineering surveys, exploration for ground water, application in mining industry.

Unit- II Reflection data processing, static and dynamic corrections, velocity determination. Preparation of seismic sections migration, analysis of analog records, automatic processing of digital seismic data, demultiplexing, TAR, velocity analysis, velocity spectra and velocity scan, automatic statics, picking, stacking, spiking deconvolution, dereverberation, whitening, time variant frequency filtering, apparent velocity filtering. AVO analysis, different methods of migration, automatic migration, wavelet processing.

Unit-III Seismic section plotting, display types, picking of events, marking-isochron & isopach maps, geological interpretation, application of reflection methodl 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; fit falls in interpretation.

Unit-IV Hydrocarbon indicators, bright spot, seismic attributes, AVO analysis, vertical seismic profiling, equipment, configurations like deviated well, walk away, offset VSP etc., applications, 3D data processing and interpretation, visualization in an animated interactive environment.

Unit-V

Seismic stratigraphy, geological sea level change model, depositional patterns, seismic sequence, seismic facies, reflection character, synthetic seismogram, modeling concepts, high resolution seismic surveys, shallow engineering surveys and suitable energy sources, 4C, 4D recording, seismic tomography, reservoir applications of petrophysics concepts, generation and recording of shear waves, energy sources, geophones, recording, processing, section plotting, interpretation Vp/Vs as lighology indicator, hydrocarbons, engineering applications.

Books:

1. Introduction to geophysical prospecting, M.B.Dobrin.
2. Applied Geophysics, W.M.Telford et. al.
3. Exploration seismology, Sheriff. R.E.
4. An introduction to seismic interpretation, R. Mcquillin et.al.
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 Tathamzand MD McCormack
8. Fundamentals of seismic tomography, Lo and Inderweisen
9. Reservoir studies, SEG publication.

COs	**Upon successful completion of the course, the student will be able to:**	Cognitive level
CO1	Understand the seismic refraction data processing and different interpretation techniques for land data and marine data. Example Delay time method and Generalised Reciprocal Method.	Understanding
CO2	Understanding the robust data processing flow and the reflection data processing section	Understanding
CO3	Understanding the seismic method for oil & gas exploration, groundwater exploration and coal exploration.	Knowledge
CO4	The student has demonstrated the hydrocarbon indicators, AVO analysis	Knowledge
CO5	Seismic stratigraphy information with seismic section	Understanding

Course Outcomes (COS):

7. Develop simple seismic data interpretation programe and seismic refraction data interpretation.
8. Able to do data processing in the computer-based software for reflection seismic data
9. Understanding the role of seismic method in oil & gas exploration and also groundwater, coal explorations.
10. Visualize clearly the seismic sections of hydrocarbon zones with different indicators.
11. Apply the concepts of development of surfaces while designing/analyzing any product.
12. Recognize the significance of seismic stratigraphic studies in oil industry.

Course Learning Outcomes (CLOs)

Upon successful completion, students will have the knowledge and skills to:

6. Demonstrate the seismic refraction data interpretation techniques at lab
7. Critically evaluate seismic reflection techniques, acquisition procedures, and survey designs for various subsurface targets.
8. Demonstrate an advanced understanding of the seismic data processing methods and flow chart.
9. Employ appropriate modeling methodologies, and evaluate strengths, weaknesses, and limitations.
10. Infer physical properties at depth and formulate geological interpretations from those properties.
11. Demonstrate effective team-work and communication skills

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	1	1	2	1	-	-	-	-	-	-	-	-	-	2
CO3	3	1	2	-	-	-	-	-	-	-	1	-	1	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	3
CO5	2	2	2	-	-	-	-	-	-	-	-	-	1	3

MARINE GEOPHYSICS Common syllabus for M.Sc. (Tech) Geophysics - IV semester			
Course Category	Basic Science core course	Course Code	GS 404
Course Type	Theory	Lectures-Training-Practical	4-0-3
Prerequisites	Basic knowledge of math and physics	Internal Assessment Semester End Examination Total Marks	20 80 100

GS 404: MARINE GEOPHYSICS

(Common paper with MGS404 Marine Geophysics in M Sc Marine Geophysics)

Course Objectives

Upon completion of this course, the students will acquire an understanding of the following topics:

1. To educate the students on the origin of oceans and continents.
2. To educate the students on the importance of bathymetry, marine geophysical instrumentation and surveys.
3. To Impart the knowledge to the students on sea floor's spreading and objectives of marine geophysical surveys

Unit I: Oceans and Seas, origin of continents and oceans, salinity, temperature and density of sea water, physiography and divisions of the sea floor, continental shelves, slopes and aprons, submarine canyons and deep sea channels, sea mounts and abyssal plains, turbidity currents and submarine sedimentation, the mid oceanic ridge systems and its structure, aseismic ridges, various types of ridges in the Indian ocean region, the continental fracture system and island arcs, occurrence of offshore mineral deposits and hydrocarbons, hotspots, lithospheric deformation of central Indian ocean region, mineral resources of the sea: surficial deposits of the shelf and deep sea, heavy mineral placers, calcareous shells, pearl oysters, phosphorites, glauconite, barium sulfate carcretions, sand and gravel, extensions of ore deposits, hydrocarbon potential of the shelf and offshore sedimentarybasins.

Unit II: Marine Geophysical instrumentation and surveys: Adaptation of geophysical instruments for marine surveys, for measurements at the sea surface and under water, geophysical equipment currently in use and board research vessel(Gravity, magnetic and seismics), complement of equipment on board the survey ship and layout of equipment, towing logistics, survey procedures and planning of survey lines, marine magnetometers, marine gravimeters, surface and under water gravimeters, Graf Askanian, Lacoste Romberg and vibrating string gravimeters, calculation of gravityanomalies.

Unit III: Bathymetry; echosounding, bathymetric charts, bathymetry as an adjunct to geophysical surveys, submersibles, seabed mapping by side scan sonar, multibeam, liderand other surveys, seabed sampling, dredging and coring, marine geophysical surveys for sealed resources, site selection for production platforms, tunneling, waste disposal etc. CRZ, its concept, Integrated Coastal Zone Development. Law of Seas, Legal Continental Shelf (LCS), Geophysical studies for identifying LCS. Other International Conventions for exploration of deep-sea-resources.

Unit IV: Oceanic magnetic anomalies, sea floorspreading, the Vine-Mathews hypothesis, geomagnetic time scale and dating the ocean floor, linear magnetic anomalies. Heat flow: Earth's internal sources of heat, transfer of heat within the earth, measurements at the ocean bottom, heat flow probes and measurements. Oceanic heat flow, ocean ridges and ocean basins, marginal basins, riftvalleys.

Unit V: Objectives of marine geophysical surveys, marine geophysical surveys for seabedresources, engineering investigations, deep sea geological mapping, delineation of continent-oceanic boundary, geological

mapping in the coastal zone. Results of some rare studies. Geophysical anomalies of trenches, active and passive margins, ridges, island arcs, lithospheric deformation in the Indian Ocean region etc. Large scale and small-scale structural features of the oceanic crust from seismicsurveys.

Books:

1. Marine geophysics by EJWJones
2. Physics and geology by Jacobs, Russel andWilson
3. Introduction to geophysical prospecting by MBDobrin
4. Applied geophysics by WM Telford, et.al.
5. GeodynamicTurcuttoe
6. The interior of the Earth by MHPBott.
7. The continental shelf and the exclusive economic zone by DonatPharand – 1993-404 page.
8. Law of Seas: UN Convention on the Law of the Sea www.en.wikipedia.org/wiki and www.guestia.com/library
9. The legal continental shelf www.springer.com
10. International Environmental Law and Economic by P.K. Rao, 2002.books.google.co.in
11. 7.M.S. Swaminathan Report on CRZ (website)

Upon the successful completion of the course will provide		**Cognitive Level**
CO1	To provide the basic knowledge on ocean's and seas and the origin of continents and oceans.	Understanding
CO2	To educate the students on the marine surveys.	Understanding
CO3	To educate the students on the sea bed maping and concept of CRZ.	Understanding
CO4	To educate the student on the oceanic magnetic anomalies and oceanic heat flow.	Analysing
CO5	To educate the student on the deep sea geological mapping and seismic surveys.	Analysing

Course Specific Outcome (CSOs)

CSO1 The students become familiar with heavy mineral placers and extensions of ore deposits

CSO2 The students become familiar with procedures of marine surveys and laws of seas, Integrated coastal zone development.

CSO3 The students will be acquainted with Measurements of the ocean bottom and marine geophysical surveys

Learning Outcomes (LOs)

LO1: After the course completion the students will have broad understanding on the importance of oceans and seas.
LO2: The students will learn on the adaptation of geophysical instruments
LO3: The students will learn the importance of bathymetric and international conventions for exploration of deep-sea resources
LO4: The students will get knowledge on the basic of ocean magnetic anomalies, ocean ridges and ocean basins
LO5: The students will have knowledge on the marine geophysical surveys deep-sea geological mapping and trenches.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO 1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO2**
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	1	1	2	1	-	-	-	-	-	-	-	-	-	2
CO3	3	1	2	-	-	-	-	-	-	-	1	-	1	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	2
CO5	2	2	2	-	-	-	-	-	-	-	-	-	1	1

MINING, GROUND WATER AND ENVIRONMENTAL GEOPHYSICS Common syllabus for M.Sc. (Tech) Geophysics - IV semester			
Course Category	Basic Science core course	Course Code	GS 501
Course Type	Theory	Lectures-Training-Practical	4-0-3
Prerequisites	Basic knowledge of math and physics	Internal Assessment Semester End Examination Total Marks	20 80 100

GS 501: MINING, GROUND WATER AND ENVIRONMENTAL GEOPHYSICS

Course Objectives

Uponcompletionofthiscourse,thestudentswillacquireanunderstandingofthefollowing topics:

1. To provide the knowledge on different elements in the crust, Precious and other useful substances in the upper crustal layers

2. To provide knowledge on Surface and under ground mining and their Classification, and Base metals and Ferrous metals
3. To provide knowledge on Surface investigations of groundwater-Geological method-Remote sensing- Hydrobotanical
4. To provide the knowledge on Application of Geophysical methods- Ground penetrating radar (GPR), seismic reflection and refraction, DC resistivity, electromagnetic induction, gravity and magnetic, Gradient of magnetic field, Interpretation of data

UnitI Crustal layers-upper and lower, Different elements in the crust, Precious and other useful substances in the upper crustal layers, Metallogenic provinces and periods. Classification of mineral deposits – Metallic and non metallic, Classification of metallic deposits-Ferrous and non ferrous, Base and noble metals, Sulphides, Oxides, Silicates and Carbonates, Processes of formation of mineral deposits –Igneous activity, Sedimentation, Metamorphism, Weathering and Erosion, Hydrothermalprocesses.

UnitII Surface and under ground mining and their Classification (in brief), Mineral deposits of India -Base metals and Ferrous metals, Geological mapping-Geophysical methods, Sulphide ores-Massive and disseminated ores-Prospecting strategies-examples, Iron ores-Strong and weak magnetic iron ores,genesis-prospecting.

Unit III Manganese, Chromium, Placers-Prospecting strategies, Diamonds, Genesis of coal deposits of India - Geophysical prospecting, Logging in mineral exploration, Synergic interpretation.

UnitIV Surface investigations of groundwater-Geological method-Remote sensing-Hydrobotanical, Review of electrical resistivity and seismic refraction methods –

Groundwater exploration, Buried channels, Sea water intrusion. Identification of contaminant and its movement- through hydrochemical methods, Geophysical strategies- Electrical resistivity. Self potential, saltwater interface demarcation in coastal aquifers and water logged areas by electromagneticmethod

UnitV Geophysics and earth's environment, Environmental problems: landslides, contaminated land studies, DerectLand Investigations, buried tanks, buried voids and contaminated ground, depth to bedrock, Landfill Investigations, buried pipes, Municipal waste detection, chemical waste disposal sites, sites of industrial waste, water contaminates zones, Application of Geophysical methods- Ground penetrating radar (GPR), seismic reflection and refraction, DC resistivity, electromagnetic induction, gravity and magnetic, Gradient of magnetic field, Interpretation ofdata.

Books: 1. An Introduction to Applied and Environmental Geophysics By John M. Reynolds
2. GeophysicsinMiningandEnvironmentalProtectionby Idziak,AdamF.;Dubiel, Ryszard(Eds.)
3. Environmental Geophysics: A Practical Guide (EnvironmentalEngineering) (Hardbound) By DieterVogelsang
4. An Introduction to Applied and Environmental Geophysics by John M.Reynolds
5. Environmental and Engineering Geophysics by Prem V. Sharma, Universityof Copenhagen
6. Mining Geophysics, SEG,Volume-I
7. Ground water Hydrology,D.K.Todd
8. Geophysical practice in mineral exploration and Mapping, T.S. Rama Krishna

Upon the successful completion of the course will provide		**Cognitive Level**
CO1	The knowledge on different elements in the crust, Precious and other useful substances in the upper crustal layers of the earth.	Understanding
CO2	To provide information of Surface and under ground mining and their Classification (in brief), Mineral deposits of India	Understanding
CO3	To provide the occurrence and distribution knowledge on Manganese, Chromium, Placers-Prospecting strategies, Diamonds, and its Genesis of coal deposits of India	Understanding
CO4	To provide the basic concept of Identification of contaminant and its movement- through hydrochemical methods, Geophysical strategies- Electrical resistivity. Self potential, saltwater interface demarcation in coastal aquifers and water logged areas by electromagnetic method	Analysing
CO5	To give general overview of Application of Geophysical methods- Ground penetrating radar (GPR), seismic reflection and refraction, DC resistivity, electromagnetic induction, gravity and magnetic, Gradient of magnetic field, Interpretation of data.	Analysing

Course Specific Outcome (CSOs)

CSO1 Students become familiar with elements in the crust, Precious and other useful substances in the upper crustal layers of the earth

CSO2 Students will acquire the knowledge on Surface investigations of groundwater

CSO3 To give general overview of Application of Geophysical methods- Ground penetrating radar (GPR), seismic reflection and refraction, DC resistivity, electromagnetic induction, gravity and magnetic, Gradient of magnetic field, Interpretation of data

Learning Outcomes (LOs)

LO1: After the course, students will have broad understanding of earth crustal layers, and available natural resources.
LO2: Students will learn the distribution of different kinds of minerals in India.
LO3: Students will learn about different Types of mining opertations.
LO4: Student will learn the importance of remote sensing, geological, and Geophysical methods for groundwater explorations
LO5: Students will learn theApplciation of Geophysical methods for addressing different environmental problems.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO 1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO2**
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	1	1	2	1	-	-	-	-	-	-	-	-	-	2
CO3	3	1	2	-	-	-	-	-	-	-	1	-	1	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	2
CO5	2	2	2	-	-	-	-	-	-	-	-	-	1	1

Environmental Hydrology & Water quality Common syllabus for M.Sc. (Tech) Geophysics - IV semester			
Course Category	Basic Science core course	Course Code	GS 502
Course Type	Theory	Lectures-Training-Practical	4-0-3
Prerequisites	Basic knowledge of math and physics	Internal Assessment Semester End Examination Total Marks	20 80 100

GS 502 : Environmental Hydrolgy& Water quality

Course Objectives

Uponcompletionofthiscourse,thestudentswillacquireanunderstandingofthefollowing topics:

1. To provide the basic structure of water molecule and rock water interactions, its source mechanism.
2. To provide a systematic procedure of water sampling
3. To provide the knowledge of water quality analysis and interpretation.

UNITI: The water molecule, isotopic composition of waters-physical and chemical properties of water -electrolytic dissociation, solubility product, hydrogen ion concentration, specific electrical conductance, water and electrolytes, organic constituents, dissolved gases. Law of mass action, chemical equilibrium-activity coefficient, ionic strength, Debye-Huckel principle, reporting equilibrium status of water and related norms, calacite, dolomite, fluorite equilibrium-dissolution of solid and liquids, factors causing solubility changes, solubility in aqueous solution, saturation index, pH and solubility, redox potential, stability diagrams, specific conductance of aqueoussolutions.

UNITII: Geochemical processes- Adsorption and ion exchange, ion selectivity, adsorption process base exchange index, adsorption and filter effect; Geochemical classification of waters-magmatic, meteoritic, juvenile waters, oil field brines, thermal waters- Subterranean waters in oil fields-case histories. Chemical dissolved constituents-major, minor and traces in ground water-source mechanism

.

UNITIII: Objective of sampling, plan, extent, frequency of sampling, precautions. Standard laboratory techniques-titrimetric, colorometric, and spectrophotometry. Instruments-visible and UV spectrophotometers, ion Selective electrodes, DO meters, pH and conductivity meters, flame photometers and atomic absorption Spectrophotometer, Inductively Coupled Plasma (ICP). Preparation of the standards-estimation and Reporting units. In-situ measurements-pH, conductivity, salinity and dissolved oxygen, chemical demand, biological demand. Bacteriologicalstudies.

UNIT IV: Interpretation of physical and chemical data of water, methods of illustration-pictorial, bar, circular radial, multivariate schoeller diagrams, four coordinate diagram, stiffs diagram, horizontal and vertical scale diagram. Plotting on maps-Piper, Wilcox, SAR, and Gibbs representation, Durov plots. Statistical techniques in presenting hydrochemical data-correlation, discriminant analysis, factor analysis, principle component analysis, Exposure to Statistica Soft-ware. Outlines of global hydrochemical soft-ware-Wateq, Phreeq, Aquachem, MINTEQA2 and UNESCO hydrochemical softwater.

UNITV Environmental hydrology- relation with other sciences- Ecosystem, ecological stability, imbalance and pollution. Global threat -EInino effect - Green House Effect-Ozone layer depletion, Global Warming, acid rains, impact on hydrological environment, Ground water pollution- sources and classification- water quality above and below water table. Standards of water- Indian, World Health Organisation, Environmental Protection Agency. Water suitability norms for drinking -Piper classification, agricultural classification-Kelly's ratio. Sodium adsorption ratio, residual sodium carbonate, magnesium hazard, soluble sodium percent, Wilcox classification, genesis of water through-Gibbs, Durov plots. Piper classification. contaminant migration, control and prediction, Environmental ProtectionLaws.

BOOKS:

1. Study and interpretation of the chemical characteristics of Natural wate, USGS Edition , J.D.Hem
2. The properties of groundwater, GeorgeMathess
3. Facet of Hydrology,J.C.Rodda.

Contd...

4. Advances in Hydrosciences Vol.2 ,Ven teChow.
5. Physical and Chemical hydrology, Patrick A.Domenico and FranklinW.Schwartz.
6. Standard methods for the examination of water and waste water, American Public Health Association, Ed.1980.
7. Hand Book of applied Hydrology, Ven teChow.
8. Applied Hydrogeology,C.W-Fetter.
9. Groundwater Hydrology,D.K.Todd.
10. Concepts of Ecology,Edward.J.Kormondy
11. Protection of public water supplies from groundwater contamination, US Environmental Protection Agency Publication1985
12. Groundwater resources evaluation,W.C.Walton
13. Groundwater Hydrology,H.Bouwer
14. Hydrogeology,K.R.Karanth

Upon the successful completion of the course will provide		**Cognitive Level**
CO1	Provide the knowledge of structure of water molecule, and its physical and chemical properties. To provide the basic concepts of electro-chemistry.	Understanding
CO2	Provide the over view of Geochemical process in natural chemistry. And also to provide the major anion and cations in the natural waters, and its source mechanisms.	Understanding
CO3	Proved the knowledge on scientific objectives, field data collection of water sampling for major and minor ions	Understanding
CO4	Provide the knowledge on laboratory measurements (Analysis) of water quality data using different techniques. And also interpretation of water quality data using different software's.	Understanding
CO5	The knowledge of impact of global warming, green house effect, etc., on hydrological regime. And WHO and BIS standards for drinking water.	Understanding

Course Specific Outcomes (CSOs)

1. To understand the basic concepts of hydrochemistry, rock water interactions.
2. To provide the knowledge of water quality analysis for major ions
3. To provide the knowledge of interpretation of water quality data
4. To provide the application of hydrochemistry data for understanding the dynamics of ground/surface water resources.
5.

Course Learning Outcomes (C LOs)

1. Students will gain knowledge on the concepts of hydrochemistry, rock water interactions.
2. Students acquire knowledge on the importance of water quality analysis for major ions

3. Students learn the laboratory measurements (Analysis) of water quality data using different techniques. And also interpretation of water quality data using different software's.

4. Students will acquire knowledge scientific objectives, field data collection of water sampling for major and minor ions.

5. Students can able to understand the impact of global warming, green house effect, etc., on hydrological regime. And WHO and BIS standards for drinking water.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO 1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO2**
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	1	1	2	1	-	-	-	-	-	-	-	-	-	2
CO3	3	1	2	-	-	-	-	-	-	-	1	-	1	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	2
CO5	2	2	2	-	-	-	-	-	-	-	-	-	1	1

PETROLEUM GEOLOGY & GEOPHYSICS Common syllabus for M.Sc. (Tech) Geophysics - IV semester			
Course Category	Basic Science core course	Course Code	GS 503
Course Type	Theory	Lectures-Training-Practical	4-0-0
Prerequisites	Basic knowledge of math and physics	Internal Assessment Semester End Examination Total Marks	20 80 100

GS 503: PETROLEUM GEOLOGY & GEOPHYSICS

(Common paper with MGS 302 Petroleum Geology & Geophysics in M Sc Marine Geophysics)

Course Objectives

Upon completion of this course, the student swill acquire an understanding of the following topics:

1. To provide the knowledge of Petroleum – occurrence – distribution- chemical and physical properties
2. To provide the knowledge on Reservoir – rocks – properties – Fluids, water – oil- Natural gas- properties
3. To provide the knowledge on Gravity and Magnetic methods in petroleum exploration

UnitI Petroleum – occurrence – distribution- chemical and physical properties – Origin- various theories, source rock, organic matter – Maturation into petroleum – P&T conditions, Migration – primary andsecondary**.**

UnitII Reservoir – rocks – properties – Fluids, water – oil- Natural gas- properties, Traps- structural – stratigraphic – combination, seals, sedimentary basins – cratonic – convergent and divergent margin basins – classification, Category-1 basins ofIndia

UnitIII Gravity and Magnetic methods in petroleum exploration – surveys – Land and ocean areas – differences – data processing operations, Gravity anomalies – salt domes – stratigraphic traps. Magnetic methods – basement mapping, computer oriented methods.

UnitIV Seismic data processing – outlines, preparation of seismic section, Reflection character- structure, pitfalls – migration 2D & 3D significance – velocity pull up, structure identification.

UnitV Seismic stratigraphy – Unconformities – seismic sequences – reflection pattern – depositional environment – basin history – construction, Modelling concept – Reservoir parameters – forward and inverse, direct detection – Bright spots – flat spots Gas hydrates, Coal bedmethane.

Books:

1. Ravi Bastia: Geologic settings and petroleum system of India-East coast off shore basins- Concepts andapplication.
2. A.I.Levorson: Geology ofPetroleum
3. R.C.Selly& David C.Morri:-Basic concepts of petroleumGeology
4. Jutshi P.L and Pawar M.S:Geology of Petroleum basins ofIndia
5. Weimer P &R.M.Slatt: Introduction to petroleum Geology of deep water settings, AAPG studies in Geologyseries
6. Michael D.Max, Arthur H.Johnson& William P.Dillon: Economic geology of natural gashydrates.

COs	**Upon successful completion of the course, the student will be able to:**	Cognitive level
CO1	Understand the origin of the hydrocarbon and physical and chemical properties of the hydrocarbon generation,	Understanding
CO2	Understanding the reservoir characteristics, and sedimentary basin of India	Understanding
CO3	Understanding the role of Gravity and Magnetic survey for hydrocarbon	Knowledge
CO4	The seismic data processing for hydrocarbon exploration. The student has demonstrated the hydrocarbon indicators, AVO analysis	Knowledge
CO5	Seismic stratigraphy information with seismic section, Seismic stratigraphy – Unconformities – seismic sequences – reflection pattern – depositional environment – basin history – construction	Understanding

Course Outcomes (COS):

1. Demonstrate a working knowledge of the terminology of geology, geophysics, and others, with a comprehensive understanding of the earth's interior, surface, resources, climate, biosphere, and the different methods used to study them.
2. The student is introduced to petroleum with a detailed study of its origin, kerogen and distribution of petroleum in space and geological time.
3. The student is introduced to the different petrographic and geochemical methods of petroleum exploration along with their applications and limitations.
4. The student is introduced to the descriptive study and different mechanisms of migration of oil and gas as relevant to the petroleum industry.
5. The student is introduced to a detailed study of reservoir rocks; their characterization, blowout problems along with a detailed description of petroleum traps
6. The student is introduced to a detailed study and application of oil field waters and cap rocks. The petroleum geology of important Indian basins is discussed with an outline of oil and gas exploration with reserve estimation. A short account of well logging techniques relevant to petroleum exploration is also discussed.
7. Develop proficiency in understanding and conveying complex geological ideas and concepts with clarity in written, online and oral communication and to develop positive values and aptitude necessary to obtain and maintain employment as a professional geologist or to further their education.

Course Learning Outcomes (CLOs)

Upon successful completion, students will have the knowledge and skills to:

1. Students will learn, where hydrocarbons come from and how they accumulate
2. Students also understand the requirements for the formation of hydrocarbons
3. Reservoir Properties
4. Reservoir types and Terminology
5. The student also learns to visualize, synthesize, apply and integrate field work observations with theory via practical knowledge and skills acquired in the class room and laboratory in order to describe natural geological processes.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	1	1	2	1	-	-	-	-	-	-	-	-	-	2
CO3	3	1	2	-	-	-	-	-	-	-	1	-	1	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	3
CO5	2	2	2	-	-	-	-	-	-	-	-	-	1	3

Disaster Management Common syllabus for M.Sc. (Tech) Geophysics - IV semester			
Course Category	Basic Science core course	Course Code	GS 504
Course Type	Theory	Lectures-Training-Practical	4-0-0
Prerequisites	Basic knowledge of math and physics	Internal Assessment Semester End Examination Total Marks	20 80 100

GS 504- Disaster Management

Course Objectives

Upon completion of this course, the students will acquire an understanding of the following topics:

1. To educate the students on the natural disasters and disaster management.
2. To impart knowledge on the natural disasters.
3. To educate the students on various national and international agencies to combat will natural Disasters

Unit I

Introduction to Natural Hazards: various types of hazards, natural and manmade: Cyclone, flood, land slide, land subsidence, fire, earthquakes, blow outs and Tsunami, assessment and risk calculation, Disaster Mitigation, Preparedness; Techniques of monitoring, design against the disasters, pre-disaster risk & vulnerability reduction, post disaster recovery & rehabilitation, infrastructure development. Remote-sensing and GIS applications, geo data base, decision supportsystem

Unit II

Earthquake Hazard: Status of earthquake occurrence, geographical distribution; case histories of various earthquake hazards, Prediction and prepared ness, assessment of seismic hazard and risk,Seismic zoning and microzonation. Seimic zonation in India, Earthquake prone areas in India, action mitigation; Tsunami-causes, alarming, hazard mitigation and management.

Unit III

Landslides: Classification of landslides, Types of slope failure, Slope Mass Rating (SMR) classification, Causative factors, Landslide Hazard Zonation, Factor of Safety analysis, Slope stabilization measures. Sinkholes and Subsidence, identification of areas with special reference to India, landslide prevention tasks; Gas blow outs from wells and refineries, Oil and gas pipe line leakages, Indian case histories

UNIT – IV

Floods: Causes, magnitude and frequency of floods, channel migration, bank erosion, catchment erosion, flood forecasting, nature and extent of flood hazards; Areas of flood prone activity in India, their seveiarity. Flood combat mitigation; Storm surges, thunder storms, lightening, tornadoes and hurricanes. Indian examples – floods, landslides in Uttarakhand, cyclones in southern peninsula.

UNIT – V

Coastal Hazards: cyclones, tsunamis, coastal erosin and causes, Sea Level Rise and its Dynamics, preventive measures, plantation, Mangrove areas in India, coastal erosion constructions; Volcanic Eruptions-Products and Hazard Effects, prediction, risk evaluation and management., global case histories; Disaster policy in India; Disaster Management Act of 2005; National and International Agencies: NDMA,NIDM, NCMC; UN, UNDRO, UNESCO, UNDP; Role ofNGOs.

Suggested Books:

1. Bell, F.G., 1999. *Geological Hazards*, Routledge,London.
2. Bryant, E., 1985. *Natural Hazards*, Cambridge UniversityPress.
3. Smith, K., 1992. *Environmental Hazards*. Routledge,London.
4. Subramaniam, V., 2001. *Textbook in Environmental Science*, NarosaInternational
6. Keller, E.A., 1978. *Environmental Geology*, Bell and Howell,USA.
7. Patwardhan, A.M., 1999. *The Dynamic Earth System*. PrenticeHall.
8. Valdiya, K.S., 1987. *Environmental Geology – Indian Context*. Tata McGrawHill.

Upon the successful completion of the course will provide		**Cognitive Level**
CO1	Incorporated the basics of Hazards both Natural and Manmade	Understanding
CO2	To impart knowledge about the Earthquakes and Tsunami.	Understanding
CO3	To develop the knowledge about landslides and land subsidence.	Understanding
CO4	To inculcate the knowledge of assessment and risk calculation, Disaster Mitigation etc.	Analysing
CO5	To impart knowledge on Seismic zoning and microzonation. Seimic zonation in India.	Analysing

Course Specific Outcome (CSOs)

CSO1 : The student will understand Preparedness; Techniques of monitoring, design against the disasters.

CSO2 : They will thoroughly understand the concepts of Landslides, Classification of landslides, landslide prevention tasks.

CSO3 : They will learn about various concepts related to Floods: Causes, magnitude and frequency of floods

CSO4 : They will learn more concepts related to Storm surges, thunder storms, lightening, tornadoes and hurricanes.

Learning Outcomes (LOs)

LO1 : Students will be able to comprehend the importance of Natural Hazards.

LO2 : They acquired the knowledge about Earthquake prone areas in India, action mitigation.

LO3 : They will understand the need to study the Coastal Hazards: cyclones, tsunamis, coastal erosion and causes, Sea Level Rise and its Dynamics, preventive measures.

LO4 : They will be able to integrate and understand the Causative factors, Safety analysis for the hazards.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO 1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO2**
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	1	1	2	1	-	-	-	-	-	-	-	-	-	2
CO3	3	1	2	-	-	-	-	-	-	-	1	-	1	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	2
CO5	2	2	2	-	-	-	-	-	-	-	-	-	1	1

Water Resources, planning and Management Common syllabus for M.Sc. (Tech) Geophysics - IV semester			
Course Category	Basic Science core course	Course Code	GS 601
Course Type	Theory	Lectures-Training-Practical	4-0-0
Prerequisites	Basic knowledge of math and physics	Internal Assessment Semester End Examination Total Marks	20 80 100

GS 601: Water Resources, planning and Management

Course Objectives

Uponcompletionofthiscourse,thestudentswillacquireanunderstandingofthefollowing topics:

1. To provide the knowledge on Surface water resources, and formation of river, river basin and water divide, formation of river valleys, flood plains, fluvial deposits, alluvial fans, lakes, deltas, solution valleys and karst topography.
2. To provide the knowledge on Hydrographs, and its application in flood forecasting.
3. To provide the knowledge on hydro-meteorological data collection, analysis.
4. To provide the basics knowledge on Watershed management, its importance in Water resources management.

UNIT-I

Surface water resources, Definition of river, river basin and water divide, formation of river valleys, flood plains, fluvial deposits, alluvial fans, lakes, deltas, solution valleys and karst topography, Sediment discharge, transportation and sediment yield, suspended load and bed load measurements. Runoff, virgin flow, surface runoff, overland flow, subs surface runoff, groundwater runoff, direct runoff, base flow and total runoff. Precipitation excess, effective precipitation, disposition of total precipitation to total runoff,runoffphenomena,factorsaffectingrunoff,dispositionofstormrainfallandestimationofrunoff, ϕ-index, W-index and W-minimumindex.

UNIT-II

Hydrographs: Discharge hydrograph, factor affecting shape of hydrograph, components of hydrograph, base flow separation methods. Unit-hydrograph, S-hydrograph, Dimension less unit hydrograph, Flood discharge, flood volume and duration of floods, Flood estimation, causes of flood, factors affecting flood flow, flood flow determination.Flood routing: Definition and scope, flood routing methods. Flood forecasting and control methods.

UNIT-III

Precipitation, Forms of Precipitation, Measurement of rainfall and snow, Types of gauges, Non recording, self-recording and Storage gauges, Rain gauge network, Interpretation of precipitation data. Concept of Infiltration, Factors affecting Infiltration, Measurement of infiltration, Single ring and Double ring infiltrometers, Flood type infiltrometers, Rainfall Simulators, Hydrograph analyses to estimate infiltration, Relation of infiltration to run-off, Evaporation & Evapotranspiration Definitions,Factors effecting Evaporation, Measurement of evaporation. Estimation Transpiration Determination of transpiration, Evapotranspiration Methods ofestimation.

UNIT-IV

Watershed: Concept, Characteristics, Size, Shape, Physiography, Climate, Drainage, Land-use, Hydrological parameters. Basic data collection, Concepts of Integrated Study of Watershed Management. Conditions to develop watershed, Geological Considerations, Types of Watersheds, Integrated studies to

develop watersheds. Rain water structures, design and Economic aspects. Soil and water consideration. Role of Remote sensing in establishing watersheds.

UNIT-V

Contour Demarcation, Levelling and shaping, Bunding, Hedging, Terracing, Gully control, Check dams, Mini percolation tanks, , Boundary Bunds, Contour Bunds, Dug wells, Bore wells, sub-surface dams, Tanks, Diversion structures, Soak pits and Trenches, Public soak pits, Pebble bunds, Water bunds, Water absorption Trench, Diversion drains, Vegetative Barriers, Sand bag structure, Brush wood dams, Stone check, Rock fill dam, Gabians, Sunken ponds, Farm ponds, Check walls, Check dams, pick up anicut, Nala bund.Watershed and Agricultural Practices: Afforestation, Artificial Recharge of Groundwater, Different Recharge methods.

Books:

1. Groundwater Resources Evaluation,W.C.Walton
2. Hand book of Applied Hydrology, Ven TeChow
3. Ground Water, H.M.Raghunath
4. Hydrogeology, Davis & De Wiest
5.Watershed Management,J.V.S.Murthy
6.Facets of Hydrology, John CRodda
7.Watershed Development, V.V.J.Sarma, C.Subba Rao andN.V.B.S.S.Prasad
8.Watersheds Compherehensive Development, K.V.Seshagiri Rao
9.Hydrology &Watershed Management, B.VenkateswaraRao

Upon the successful completion of the course will provide		Cognitive Level
CO1	The basic knowledge on formation of surface water bodies, and its geomorphology, and hydrological cycle, and its components.	Understanding
CO2	Provide the knowledge on Hydrographs, hydrological data collection (Flood), hydrographs analysis, and flood forecasting techniques.	Understanding
CO3	Proved the concepts of hydro-meteorological data(Rainfall, evaporation, evapo-transpiration, infiltration) collection processing, analysis, and interpretation	Understanding
CO4	Provide the knowledge of integrated Remote sensing, Geological, geo-morphological, hydro-meteorological studies for watershed management.	Understanding
CO5	The knowledge of different rainwater harvesting structures, and its imoirtance in watershed management.	Understanding

Course Specific Outcomes (CSOs)

6. To understand the basic concepts of hydrolgical cycle, and formation of surface water bodies.
7. To provide the knowledge of surface water measurements (Discharge), and flood forecasting techniques
8. To provide the application of hydrographs in flood forecasting.
9. To provide the application of hydro-meteorological data and its importance in climate studies.

Course Learning Outcomes (C LOs)

1. Students will gain knowledge on the genises of surface water bodies, and its importacne in water resources management.
2. Students acquire knowledge on the importance of rive data (stage and discharge) collection, and its application in flood forecasting
3. Students learn the applications of hydro-meteorological, geo-hydrological data in understanding of watershed characteristics.
4. Students will acquire knowledge on role of watershed management for different river basins.
5. Students can able to suggest the suitable sites for water rainwater harvesting

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO 1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO2**
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	1	1	2	1	-	-	-	-	-	-	-	-	-	2
CO3	3	1	2	-	-	-	-	-	-	-	1	-	1	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	2
CO5	2	2	2	-	-	-	-	-	-	-	-	-	1	1

Geodynamics Common syllabus for M.Sc. (Tech) Geophysics - V semester			
Course Category	Basic Science core course	Course Code	GS 602
Course Type	Theory	Lectures-Training-Practical	4-0-0
Prerequisites	Basic knowledge of math and physics	Internal Assessment Semester End Examination Total Marks	20 80 100

GS 602: Geodynamics

(Common paper with MGS 402 Geodynamics in M Sc Marine Geophysics)

Course Objectives

Uponcompletionofthiscourse,thestudentswillacquireanunderstandingofthefollowing topics:

1. To educate the students on the basic concepts of continental drift, and plate tectonics .
2. To impart knowledge to the students on tectonic frame work of india
3. To educate the students on the concepts of mantle convection models and evidences of sea level changes

UNITI Continental drift: Super continents, Gondwana land and its break up, Geophysical Evidences for continental drift and drift of India; *Plate Tectonics*: The lithosphere, Distribution of Plates, Major and Minor plates, Kinds of Plate Margins- Constructive, destructive and conservative plates, Characteristics and processes at accreting and consuming plate boundaries, Stability and stress distribution with in plates, active and passive continental margins, marginal basins, transformfaults.

UNITII Differences between plate tectonics and continental Drift, magnetostratigraphy, paleomagnetism, Plate tectonics and mountain building, relative motion of the plates, Methods of measuring plate motions, Causes of plate motions, Eulers pole of rotation, Forces acting on the lithospheric plates, the Wilson cycle, Continental collisions, seismicity and Intraplateearthquakes.

UNIT III Tectonic frame work of India- Cratons (Dharwar, Sinhbhum, Bundelkhand etc), Mobile belts, Evolution of Himalayas, Purana basins, Paleozoic, Gondawana super group, Mesozoic, Deccan Volcanic Province, Inter trappeans, Cenozoics, Siwalic group; Offshor geology, morphology and evolution of ECMI andWCMI.

UNIT IV Convection: Mantle viscosity, Concepts of mantle convection Models, Coupling between plates and mantle convection, Hot spots and Mantle plumes, Plume generation Mechanism, Evidence for mantle plumes from seismology and Geoid, Deep Continental structure of India, Heat flow and seismicity structure, models based on gravity, DSS data and seismicity (Brief descriptiononly).

UNIT V Eustatic movements, Evidences of sealevel changes, Global sea level changes, sea level changes during the Quaternary period and Pre-quaternary, Mechanism & Impact of sea level changes; Structure and composition of the oceanic and continental crusts, upper and lower mantle, inner and outer cores, Rheological effects of lithosphere, Brittle and ductile deformation, creep mechanism in the earth, Rigidity of Lithosphere, flexure of plates and compensation models in lithospheric studies. Stresses in the Lithosphere and their sources.

Books:

1. Plate tectonics and geomagnetic Reversals, Allan Cox, Free Man andCompany,1973.
2. Developments in Geotectonics, Xavier Le Pichon, Jean Francheteau and JeanBonnin, Elsevier Scientific Publishing Company,1973.
3. The earths DybnamicSuirface, K Siddhartha, Kisalaya Pub Pvt. Ltd.1999
4. Fundamentals of Geophysics, William Lowrie, Cambridge Low Price Edition,1997.
5. Geodynamics byTurcotte
6. Interior of Earth by M.H.P.Bott
7. The Encyclopedia of Solid Earth Geophysics by David E.James
8. Plate Tectonics and Crustal Evolution by Kent C.Condie
9. Deep Continental structure of India: Areview, T.M.Mahadevan, Memoir 28, Geological Society of India,1994.
10. Geodynamics ofthe Indian Peninsula and the Indian Plate Margin, R.K.Verma, Oxford & IBH Publishing Co. Pvt. Ltd,1991.
11. Gravity field, seismicity and tectonics ofIndian peninsula and the Himalayas by R.K. Verma

Upon the successful completion of the course will provide		**Cognitive Level**
CO1	Incorporated the basic principles and components of Plate Tectonics.	Understanding
CO2	To import knowledge about the Principles, Characteristics of plate margins and continental Drift theory..	Understanding
CO3	: To develop the knowledge of the fundamentals of Indian cratons	Understanding
CO4	To develop the knowledge of modern concepts of mantle convection models plume generation etc.,	Analysing
CO5	To impart knowledge on various aspects of sea level changes, Structure and composition of Oceanic & Continental crust, different stresses in the Lithosphere	Analysing

COURSE SPECIFIC OUTCOMES (CSOs):

CSO1 : The student will understand the basic principles of Sea floor spreading concepts and their applications.
CSO2 : They will thoroughly understand the concepts of plate tectonics and Continental Drift theories.
CSO3 : They will learn about various concepts related to Lithosphere and heat flow studies.
CSO4 : They will learn more concepts related to Continents and Oceans

LEARNING OUTCOMES (LOs):

LO1 : Students will be able to comprehend the importance of Geodynamic process related to the Earth.
LO2 : They acquired the knowledge about internal dynamic process of the Mantle.
LO3 : They will understand the needs to study the internal structure of the Earth from the seismological studies.
LO4 : They will able to integrate the Geodynamic studies with the present concepts

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PS O1	PSO 2
CO1	2	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	3	3	2	2	-	-	-	-	-	-	-	-	-	3
CO3	3	1	3	-	-	-	-	-	-	-	-	-	1	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	3
CO5	2	3	2	-	-	-	-	-	-	-	-	-	2	3

Sequence stratigraphy and Basin Analysis Common syllabus for M.Sc. (Tech) Geophysics - V semester			
Course Category	Basic Science core course	Course Code	GS 603
Course Type	Theory	Lectures-Training-Practical	4-0-3
Prerequisites	Basic knowledge of math and physics	Internal Assessment Semester End Examination Total Marks	20 80 100

GS 603 Sequence stratigraphy and Basin Analysis

Course Objectives

Uponcompletionofthiscourse,thestudentswillacquireanunderstandingofthefollowing topics:

1. To provide the Definition and scope of sequence stratigraphy,
2. To provide Depositional sequences and facies control, and Sediment supply and basin subsidence, rate and accommodation
3. To provide the knowledge on Sedimentary basins – Definition and scope of basin, origin and classification.
4. To provide the knowledge on Integrated basin analysis – rates of subsidence, uplift and deformation of basin fill. Paleogeography paleo-bathymetry and paleo climate, depositional conditions and products, fluid properties, rock properties, organic matter transformation and kinetic processes

Unit – I

Definition and scope of sequence stratigraphy. Tectonic control on eustatic sea level changes. Cyclo stratigraphy. Event stratigraphy, sea level changes and offlap, onlap, downlap surfaces. Parasequences, low stand, trnsgrassive and high stand system tracts, maximum flooding Surfaces

Unit – II

Facies and facies changes. Depositional sequences and facies control. Sediment supply and basin subsidence, rate and accommodation. Surface and offshore sequence stratigraphyand integration. Seismic stratigraphy, sequence stratigraphy in well sections and applicationsof welllogs.

Unit – III

Sedimentary basins – Definition and scope of basin, origin and classification. Types of basins, Tectonic classification of sedimentary basins, Tracts :Lowstand, Transgressive, Highstand, Falling stage, Crustal evolution of sedimentary basins. Geosynclinal basins, Sedimentary basins of India- Krishna-Godavari, Mumbai offshore, Cambay basins.

Unit –IV

Stratigraphy and sedimentology of sedimentary basins. stratigraphic correlation, Facies analysis, basin mapping methods, Lithofacies maps, palaeocurrent analysis, Geohistory analysis. Thermal history. depositional systems – erosion – non depositional unconformities. Global controls of sedimentary basin development, basin subsidence, stratigraphic cycles, sedimentation, plate tectonic theories – basin initiation, fillingmechanism.

Unit – IV

Integrated basin analysis – rates of subsidence, uplift and deformation of basin fill. Paleogeography paleo-bathymetry and paleo climate, depositional conditions and products, fluid properties, rock properties, organic matter transformation and kinetic processes. Trap formation and competence. Accumulation, alteration and loss of petroleum in the reservoir. conceptual basin model – evolution and tectonics of the basin, thermal history, stratigraphic history in terms of seismic, sequences and chrono stratigraphy, maturation in source rocks, accumulation and cracking of hydrocarbons in thebasin.

Text Books

1. Andrew D. Miall – Principles of Sedimentary Basin Analysis. Springer-Verlog,1990.
2. Einsele, G. 1991. Sedimentary basins, evolution, facies and sediment budget 2nd Edn. Springer Verlog,Berlin.
3. Dore, A.G. (Ed.) 1993, Basin Modelling – Advances and Applications. NFE SpecPub.3 ElsevierAmsterdam.
4. Allen P.A. and Allen (Jr) 1990, Basin analysis: Principles and applications,Blackwell,
5. Bogges, S (2001) Principles of sedimentology and stratigraphy (PrenticeHall)
6. Emergy. D (1996) Sequence stratigraphy Black well and scientificPublications
7. Miall, A.D (1997). The geology of stratigraphic sequences.Springer/verlog
8. Mial et al (1977). Seismic stratigraphy and global changes of sea level. AAPG. V.26.
9. Doylepand Prennett. MR. (1996). Unlocking the stratigraphic record. JhonWiley

Upon the successful completion of the course will provide		**Cognitive Level**
CO1	Students will gain knowledge on the scope of sequence stratigraphy, and also the tectonic control on eustatic sea level changes.	Understanding
CO2	Students acquire knowledge on the importance of stratigraphy, and the evolution of the sedimentary basins, their importance in the earth sciences for the oil and natural gas exploration.	Understanding
CO3	Students learn the applications of geophysical methods in delineating the stratigraphic units for the exploration of natural resources	Understanding
CO4	Students will acquire knowledge on the development of sedimentary basins, basin subsidence, stratigraphic cycle, sedimentation, plate tectonic theory.	Understanding
CO5	Students can understand the process of accumulation of hydrocarbons, and the role of geophysical and geological aspects for the exploration of hydrocarbons.	Understanding

Course Specific Outcomes (CSOs)

10. To understand the basic origin and evolution of life on the planet earth
11. To understand the collection, separation, morphology, classification, and stratigraphic significance of different plant fossils
12. To study about stratigraphic distribution of major microfossils, and their applications in hydrocarbon exploration formation, distribution of coal and coal bed methane gas, and also the geological controls, and geophysical strategies of exploration of coal, and coal bed methane
13. To understand the geophysical, and geochemical aspects of the shale gas exploration

Course Learning Outcomes (C LOs)

1. Students will gain knowledge on the scope of sequence stratigraphy, and also the tectonic control on eustatic sea level changes.
2. Students acquire knowledge on the importance of stratigraphy, and the evolution of the sedimentary basins, their importance in the earth sciences for the oil and natural gas exploration.
3. Students learn the applications of geophysical methods in delineating the stratigraphic units for the exploration of natural resources.
4. Students will acquire knowledge on the development of sedimentary basins, basin subsidence, stratigraphic cycle, sedimentation, plate tectonic theory.
5. Students can understand the process of accumulation of hydrocarbons, and the role of geophysical and geological aspects for the exploration of hydrocarbons.

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO 1	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO2**
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	1	1	2	1	-	-	-	-	-	-	-	-	-	2
CO3	3	1	2	-	-	-	-	-	-	-	1	-	1	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	2
CO5	2	2	2	-	-	-	-	-	-	-	-	-	1	1

Micropaleontolgy, CBM and Gas hydrate Exploration Common syllabus for M.Sc. (Tech) Geophysics - V semester			
Course Category	Basic Science core course	Course Code	GS 604
Course Type	Theory	Lectures-Training-Practical	4-0-0
Prerequisites	Basic knowledge of math and physics	Internal Assessment Semester End Examination Total Marks	20 80 100

GS 604 Micropaleontolgy, CBM and Gas hydrate Exploration

Course Objectives

Uponcompletionofthiscourse,thestudentswillacquireanunderstandingofthefollowing topics:

1. Origin and evolution of life, Collection, preparation and preservation of microfossils. Classification of microfossils. Application of fossils in Geosciences
2. Stratigraphic distribution of major microfossil groups
3. Coal bed methane-definition, origin, generation and accumulation of coal bed methane
4. Gas Hydrates- Occurrence of gas hydrates, structure of gas hydrate, Types of gas hydrate; Geological setting of Hydrate;

Unit – I

Origin and evolution of life. Collection, preparation and preservation of microfossils. Classification of microfossils. Application of fossils in Geosciences. Elementary ideas about morphology, classification, paleoecology and stratigraphic significance of the following groups: Gastropoda, Palecypoda, Brachiopoda, Cephalopoda, Trilobita, Echinodermata and Gondwana plant fossils.

Unit – II

Collection and separation of different micro fossils from surface and subsurface samples. Stratigraphic distribution of major microfossil groups, Elementary ideas about morphology, classification, ecology, paleoecology and stratigraphic distribution of Foraminifera, Ostrocoda, Radioloaria, Pollen and Spores. Biostratigraphy – Biozones. Application of micro fossils, foraminifera particular in hydrocarbon exploration.

Unit – III

Coal bed methane-definition, origin, generation and accumulation of coal bed methane, geologcial controls of methane generation from coal; Geological and petrographic influences on coal, Pore geometry, Micropore, Mesopore and macropore, cleat System, Sorption – principles, sorption isotherms – types and interpretation. CO2, CH4 and N2 adsorption – desorption, hysteresis, Langmuir isotherm, Swelling of coal matrix isotherm construction, CH4 content determination in coal seams. Underground coal gasification, carbon dioxide sequestration Characterization of coal from geophysical studies, Global coal bed methane potentials, reserves, CBM explortion and exploitation, environmental problem, water quality utilization.

Unit – IV

Gas Hydrates- Occurrence of gas hydrates, structure of gas hydrate, Types of gas hydrate;

Geological setting of Hydrate; Stability of gas hydrates; Gas hydrate reservoir; geological indicators of Gas hydrates, Geohazard and global climate zones, Geophysical surveys for gas hydrates(Seismic, electrical and well logging), Marine seismic survey including OBS survey; acquisition, processing and interpretation, Bottom simulating reflectors(BSR), VSP and cross well seismic surveys., Well logging methods of detection and evaluationof gas hydrates.

Unit – V

Shale gas- Geologial and geophyical and geochemical aspects of shale gas expl;oration, micro seismic imaging, Environmental hazard in shale gas exploitation.

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Text Books

1. Doylep and Prennett. MR. (1996). Unlocking the stratigraphic record. JhonWiley
2. Clarkson, E.N.K. (1998). Invertibrate paleontology and evolution. IV E.D.Black Well
3. Haq. B.V. and Boersman. A (1998). Introduction to marinemicropaleontology
4. Paleontology, evolution and paleobilogy, animaldistribution (2005). P.C. Jain and M.S.Anantharaman, Vishal Publications (NewDelhi)
5. Paleontology (1946). (Invertebrate) by Henrywoods
6. Microfossils by M.D.Brasier

Upon the successful completion of the course will provide		Cognitive Level
CO1	A brief introduction on the origin and evolution of life on the planet earth, and also they will acquire knowledge on microfossils, their classification, and applications particularly in the field of oil and gas exploration.	Understanding
CO2	Basic understanding of e collection, separation, morphology, classification, and stratigraphic significance of different plant fossils.	Understanding
CO3	The outline of the stratigraphic distribution of major microfossils, and their applications in hydrocarbon exploration.	Understanding
CO4	The processes of formation, distribution of coal and coal bed methane gas, and also the geological controls, and geophysical strategies of exploration of coal, and coal bed methane	Understanding
CO5	The role of geophysical studies for the exploration of coal and coal bed methane.Students will gain knowledge of the occurrence, structure, types of gas hydrates, and also the role of geophysics for the exploration of gas hydrates.Students will acquire knowledge on accumulation and geological and geophysical, and geochemical aspects of the shale gas exploration	Understanding

Course Specific Outcomes (CSOs)

14. To understand the basic origin and evolution of life on the planet earth
15. To understand the collection, separation, morphology, classification, and stratigraphic significance of different plant fossils
16. To study about stratigraphic distribution of major microfossils, and their applications in hydrocarbon exploration formation, distribution of coal and coal bed methane gas, and also the geological controls, and geophysical strategies of exploration of coal, and coal bed methane
17. To understand the geophysical, and geochemical aspects of the shale gas exploration

Course Learning Outcomes (C LOs)

1. Students will learn about the origin and evolution of life on the planet earth, and also they will acquire knowledge on microfossils, their classification, and applications particularly in the field of oil and gas exploration.

2. Students will acquire knowledge on the collection, separation, morphology, classification, and stratigraphic significance of different plant fossils.
3. Students will learn the stratigraphic distribution of major microfossils, and their applications in hydrocarbon exploration.
4. Students will gain knowledge about the formation, distribution of coal and coal bed methane gas, and also the geological controls, and geophysical strategies of exploration of coal, and coal bed methane.
5. Students also learn the role of geophysical studies for the exploration of coal and coal bed methane.Students will gain knowledge of the occurrence, structure, types of gas hydrates, and also the role of geophysics for the exploration of gas hydrates.Students will acquire knowledge on accumulation and geological and geophysical, and geochemical aspects of the shale gas exploration

Contribution of Course Outcomes towards achievement of Program Outcomes (1 – Low, 2 - Medium, 3 – High)														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO2	1	1	2	1	-	-	-	-	-	-	-	-	-	2
CO3	3	1	2	-	-	-	-	-	-	-	1	-	1	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	2
CO5	2	2	2	-	-	-	-	-	-	-	-	-	1	1