DEPARTMENT OF GEOLOGY

SALEM-636 011

DEGREE OF MASTER OF PHILOSOPHY

M.Phil.,

GEOLOGY

[Choice Based Credit System (CBCS)]

Syllabus for University Department

OBE -SYLLABUS

(Effective from the Academic year 2018-2019 onwards and thereafter)

PERIYAR UNIVERSITY
DEGREE OF MASTER OF PHILOSOPHY (M.Phil.,)
DEPARTMENT OF GEOLOGY

REGULATIONS

(Effective from the academic year 2018-2019 0nwards)

The Department of Geology, Periyar University offers a full time one year M.Phil., course in Geology. The course of the study is suitable for those candidates want to increase their research knowledge for accelerating their career by exploring and acquire a critical understanding in the applied geology. The study is designed to provide in depth knowledge, information, and techniques. The main aim and outcome of the course as follows;

Program Educational Objectives (PEOs)

PEO1 To make critical and independent inquiry in the geosciences is included, the ability to gather and evaluate peer-reviewed literature; identify a research question; design and conduct a research plan to collect laboratory and/or field data; and interpret research results.

PEO2 To Demonstrate competence in fundamental geological skills including, minerals, rock and soil identification; interpretation of topographic maps, geologic maps, and various forms of imagery; construction of geologic maps and cross sections; three-dimensional conceptualization; and collection of organized field and laboratory data.

PEO3 To develop students to make decisions on issues of local and global environmental significance based on an understanding of the interrelationships between humans and natural Earth systems.

PEO4 To equip students with the necessary analytical skills in research to tackle complex geoscientific issues and challenges at national and/or regional levels.

PEO5 To provide a forum for the exchange of research output through projects, theses, seminars, conferences and publications.

Program Outcomes (POs)

PO1 Students will exhibit timely progress in developing their program of study in the MS program during the first year.

PO2 Students are expected to demonstrate a basic level of competency in the general field of geology and in the subject area of their research.

PO3 Students will be able to demonstrate competence in oral and written communication skills including the ability to write and present independent research, write research proposals, and the ability to read and critically evaluate relevant geological literature.

PO4 Students will be able to complete research in their field of study, including the testing of a hypothesis or answering a specific scientific question or questions formulated in conjunction with the advisor and committee.

PO5 Students will be able to demonstrate appropriate quantitative skills in their sub-discipline.

Program Specific Outcomes (PSOs)

PSO1 Apply fundamental geological principles and concepts in theoretical, practical and vocational situations.

PSO2 Solve geological problems using logical scientific methods and creative thinking

PSO3 Synthesize geological data on a range of spatial and temporal scales to make interpretations that allow for scientific uncertainty.

PSO4 Communicate geological information concisely and accurately using written, visual, and verbal means appropriate to the situation.

PSO5 Employ new and established technologies to collect and interpret geological data, recognizing their strengths and limitations.

PSO6 Acquire geological knowledge and expertise from a range of sources in a variety of situations.

PSO7 Appreciate international perspectives on geoscience and recognize the importance of global standards for collecting and reporting geological data.

1. Eligibility

Candidates who have qualified for Post Graduate Degree of this University or any other University recognized by the Syndicate as equivalent thereto shall be eligible to register for the Degree of Master of Philosophy (M.Phil.,) in their respective subject and undergo the prescribed course of study in an approved institution or department of this University.

Candidates who have qualified their postgraduate degree on or after 1stJanuary 1991 shall be required to have obtained a minimum of 55% of marks in their respective postgraduate degree to become eligible to register for the degree of the Master of Philosophy (M.Phil.,) and undergo the prescribed course of study in an approved institution or department of this University. For the candidates belonging to SC/ST community and those who have qualified for the Master's degree before 01.01.1991 the minimum eligibility marks shall be 50% in their Master's Degree.

2. Duration

The duration of the M.Phil., course shall extend over a period of one year from the commencement of the course.

3. Course of the study

The course of study for the degree shall consist of (a) Part –I comprising three written papers according to the syllabus prescribed from time to time; and (b)Part- II Dissertation.

Part-I shall consist of paper – I Research Methodology and paper – II and advanced paper on the main subject. There shall also be third paper which shall be the Core paper relating to the proposed Dissertation conducted internally by the College/Departments.

4. Scheme of the examination

Part – I Written Examination: Paper I, II & III

The examination of the paper I, II & III shall be held at the end of the six months. The duration of each paper shall be 3 hours.

4.1 The allotment of Marks for theory, internal, external, Dissertation and Viva voce are as follows.

(i) Theory Papers,
Internal: 25 Marks
External: 75 Marks Total Marks =100

(ii) Project Dissertation
Dissertation: 150 Marks
Viva Voce: 50 Marks Total Marks =200

4.2 The following procedure to be adapted to award internal mark.

i) Seminar	: 10 marks.
ii) Test	: 10 Marks
iii) Attendance	: 05 Marks
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	25 Marks

4.3 The following credits are allotted to the theory Papers and Project. Credit for theory Papers.

Part – I
Paper – I ---------- 1x 4 = 4 Credits
Paper – II ---------- 1x 4 = 4 Credits
Paper – III ---------- 1x 4 = 4 Credits
(Guide Paper)

Part – II

Project –Dissertation and Viva voce = 12 Credits
(Dissertation: 8 Credits; Viva voce: 4 Credits).

4.4 The Viva-Voce to be conducted with the following Members.

i) HOD - Member of the Viva Board.
ii) Guide - Chairman of the Viva Board.
iii) External examiner from another University area – Member of the Viva board.

4.5 The examiners will be appointed from the panel for four names of each paper (I and II) submitted by the College/Department concerned. If one examiner awards a pass mark and the other awards fail mark then the paper will be valued by a third examiner whose award of marks will be final.

4.6 The Paper III (Guide Paper) will be commonly conducted by the University and its affiliated colleges along with the papers I & II.

4.7 The respective research guide should send two sets of question papers for paper -III along with the syllabus to the University at the simulated date.

4.8 Double valuation procedure adopted for the paper III. by respective guide and the 2nd valuation by the external examiner, preferably the Viva – Voce examiner.

4.9 The following question paper pattern will be adopted.

Part - A 5 x 5 = (25Marks)
(One question from each unit with either or type)
Part - B 5 x 10 = (50Marks)
(One question from each unit with either or type)

Part – II Dissertation

The broad area of research shall be intimated within one month after the completion of the written examination. Upon satisfactory completion of coursework, M.Phil. Scholars shall undertake research work and produce a draft dissertation. Prior to submission of the dissertation, the students shall make pre-M.Phil., presentation in the department that may be open to all faculty members and research scholars, for getting feedback and comments, which may be suitably incorporated into the draft dissertation under the advice of the supervisor. Candidates shall submit the Dissertation to the University through the supervisor and Head of the Department at the end of the year from the commencement of the course which shall be valued by internal examiner (supervisor) and one external examiner appointed by the

University from a panel of four names sent by the Supervisor through the Head of the Department/Principal at the time of submitting the dissertation.

Submission or resubmission of the Dissertation will be allowed twice a year. On receipt of satisfactory evaluation reports. M.Phil., Scholars shall undergo a Viva voice examination which is to the openly defended.

5. Passing Minimum

A candidate shall be declared to have passed Part – I of the examination if he /she secure not less than 50% of the marks in each paper including paper – III.
A candidate shall be declared to have passed Part – II of the examination if his/her dissertation is at least.

All other candidates shall be declared to have failed in the said examinations.

6. Restriction in Number of Chances

No candidate shall be permitted to reappear for the written examination in any paper on more than two occasions or to resubmit a Dissertation more than once. Candidates shall have to qualify for the degree passing all the written papers and dissertation within a period of three years from the date of commencement of the course.

7. Conferment of Degree

No candidate shall be eligible for conferment of the M.Phil., degree unless he/she is declared to have passed the part of the examination as per the M.Phil., Regulations-2020.

8. Procedure for Admission

All departments in the University and Colleges/Institutions affiliated to the University shall admit M.Phil., students through an Entrance Test. Those qualified UGC/CSIR (JRF) Examination/SLET/GATE/teacher fellowship holder are exempted from entrance test. It shall be followed by an interview to be organized by the school/Department/Institution/University as the case maybe.

Only the predetermined number of students may be admitted to the M.Phil., programme.

While granting admission to students to M.Phil., Programmes. The department/ Institute/ School will pay due attention to the National/State Reservation Policy. Any event if sufficient member of candidates are not category.

9. Qualifications for A Supervisor

No teacher shall be recognized as a Supervisor unless he possesses Ph.D., degree or two years of PG teaching experience after qualifying for M.Phil., or M.Litt., Degree. Only the postgraduate departments of affiliated college and departments of the University will be recognized for conducting the M.Phil., Course, provided however, the syndicate shall have the power to decide any other institutions of higher learning / research within the University area for conducting the M.Phil., Course on merits.

10. Eligibility for Part-time

(i) Technical Staff/ Research Assistant working in the University departments.

(ii) Teacher candidates working in the Polytechnics approved by the Director of Technical Education or in Higher Secondary Schools and High Schools/Schools approved by State Board or Central Board of Secondary Education or Educational Institutions of IAF (within Periyar University area), a minimum of55% of Marks is prescribed, provided that for the candidates belonging to SC/ST community a concession of 5% marks will be given in the minimum eligibility marks prescribed.

11. Duration

The course of study shall extend over a period of one year for full-time /part-time two years from the commencement of the course. The examinations for Part –I shall be taken at the end of the 6 months for full-time/ first year part time and Part –II Dissertation at the end of the second year.

12. Scheme of the Examination

The Regulations governing the full-time M.Phil., Course with regard to the course of study, scheme of examination passing minimum, etc., and qualifications of guide conducting the M.Phil.,. Course shall apply to part-time candidates also.

13. Restriction in Number of Chances

No candidate shall be permitted to reappear for the written examination in any paper for more than two occasions or to resubmit a Dissertation more than once. Candidates shall have to qualify for the degree passing all the written papers and dissertation within a period of two years for full-time four years for part-time from the date of commencement of the course.

Syllabus for M.Phil., Applied Geology

PAPER – I

18MPAG01 RESEARCH METHODOLOGY

Course Objectives

- To get an idea on review of literature
- To apply to solving scientific written papers and thesis.
- To emphasis computer application in scientific research.
- To understand the different sampling techniques.
- To understand the applications of Remote Sensing in different fields of Geological exploration.

Course Outcome

- To understand concepts of research work.
- To know about conceptual and contemporary methods of research
- To formulate the research hypothesis and methodology.
- To identify the different research problem.
- To evaluate the different working principles of different geological instruments and understand the importance of data analysis tools.

Unit I

Importance and need for Research Ethics and Scientific Research, Formulation of Hypothesis, Identification of Problem – Literature Survey, Reference collection, Use of Libraries and Information Retrieval systems, Internet Browsing – assessing the current status- International Standard book Number (ISBN) - International Standard Serial Number (ISSN) – Discussion in the Workshop, Symposium, Conference and Seminar.

Unit II

Scientific writing – Characteristics. Logical format for writing Papers, Dissertation and Thesis and. Essential features of Title, Abstract, Introduction, Literature Review, Materials and Methods, Result and Discussion and Conclusion. Effective Illustration –Tables, Charts and Figures. Reference style. Presenting Scientific - Type of Teaching Skills - Evaluation of Teaching Skills –Pedagogy Technology.

Unit III

Computer application in scientific research-understanding of MS-Office and its uses in project documentation, presentation and analysis of data, Standardization of Data – Plagiarism in Scientific Writing - Papers-Synopsis writing –Multimedia techniques in paper presentation – Impact Factor – Scopus Index - Science Citation Index – Research Gate - Shodhganga.

Unit IV

Sampling techniques to Geological study- Geochemical analysis –classical and rapid analytical methods-AAs, ICP-MS-Principles, Instrumentation and Applications-Mineral identification techniques. Water sample collection –

Water analysis –major and trace elements and their extraction procedures-Application of Geophysical Resistivity survey in Groundwater and Mineral resource exploration - Size and shape determination of grains in Clastic rocks – Placer Deposits.

Unit V

Application of Remote sensing in resource mapping –Geophysical techniques in mineral exploration –Geochemical methods, principles and its application –Sedimentology facies analysis and its application-Application of Micropaleontology and Stratigraphy in Petroleum Exploration.

Text / Reference Book

1. Kothari C.R. (1990) - Research methodology, methods and techniques, New Age Lmt Publishers.
2. Dana, E.S.,(1955),Text book of Mineralogy, John Wiley., Deer
3. Gupta R.P. (2005), Remote Sensing in Geology, Springer Verlag Edition
4. Jonathan Anderson et.al.,(1970).-Thesis and Assignment Writing 0-Wiley Eastern Ltd., New Delhi.
5. JonesR.w. (1996).Micropaleonotology in Petroleum Exploration, Caarendon Press, Oxford
6. Karanth .K.R. (1987)Grounwater Assessment and Management, Tata McGraw Hill, New Delhi.
7. Lillisand Kiefer R.W., (2000), Remote Sensing and Image Interpretation JohnWiley SMS, New York.
8. Maeve O' Connon R. and Peter Woolford,(1976).-Writing Scientific Papers in English
9. John F.Koegel Buford (2005).-Twelfth Edition-Pearson Education-Multimedia Communications – Directions & Systems
10. Parsons, C.J. (1973)-Thesis and Project work –Allen and Unwin Ltd.,London
11. Pettijohn, F.J., (1975) Sedimentary rocks Harper an drow.
12. Todd.D.K. (2003). Groundwater Hydrology, John Wiley and Sons, New York.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	2	1	1	3	3	1	2	3	2	3
CO 2	3	2	2	1	1	3	2	2	2	3	2	3
CO 3	3	2	1	2	2	3	2	1	2	3	2	2
CO 4	3	2	3	3	3	3	3	2	2	3	3	3
CO 5	3	2	2	3	3	3	2	1	2	3	2	3

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective and Cognitive level: K1- Remembering, K2-Understanding& K3- Applying.

PAPER II

18MPAG02 ANALYTICAL AND INSTRUMENTATION TECHNIQUES

Course objectives

- To understand the microscopic observation of rocks and minerals' thin sections.
- To assess the paleontological application and methods of sampling.
- For emphasis the sedimentary environmental modeling.
- To understand the sampling methods and groundwater exploration.
- To understand the remote sensing and GIS applications.

Course Outcome

- To evaluate the optical properties rocks and minerals.
- Analytical ability on Foraminifera and nano-fossils.
- Knowledge and skill in sedimentary environmental modeling.
- To get knowledge on field investigation of samples.
- Software knowledge on remote sensing and GIS.

Unit I

Petrological microscope, Ore microscope and Scanning electron microscope - Preparation of thin section - Preparation of rock powder for chemical analysis Classification of Minerals - Physical properties of mineral, Optical properties of mineral – Processing of Minerals and Ore Formation - Isomorphism and Polymorphism – structure of silicates – Transmitted polarized light microscopy and optical properties of uniaxial and Biaxial Minerals; Biaxial interference figures and their optic sign – Acute bisectrix figure – obtuse bisectrix figure –optic axis figure flash figure – cystal orientation – extinction angle – sign of elongation.

Unit II

Historical development, current and future trends in Marine Micropaleontology. Sampling methods, processing techniques, separation and illustration of microfossils. Foraminifera: Systematic position, test morphology, classification, ecology and paleoecology and application of foraminifera in paleodeptth, paleo temperature estimation of Ostracodes, Calcareous Nano fossils, Radiolarian, and Conodonts. Role of Micropaleontology in petroleum exploration.

Unit III

Concepts of sedimentary environmental modeling, cycles and completeness of sedimentary record correlation of sedimentary sequences, modern methods in paleoenviromental reconstruction and Hydrocarbon exploration – Heavy mineral separation methods - Basic concept and techniques of X-Ray Diffraction (XRD). X-Ray Fluorescence (XRF) and Differential Thermal Analysis (DTA).

Unit IV

Sampling methods and principles - Types of sampling, sampling interval - Quality of Ground Water – physical, chemical and Biological constituents of Groundwater - Flame photometer and UV spectrometer: Basic principles, Parts and operation and mechanism - Groundwater in Crystalline and Sedimentary systems- Piezometric tests- Pumping tests - Basin yield- Sea water intrusion-Sources of groundwater contamination- Groundwater and Economic mineralization - Groundwater depletion and remedial measures.

Unit V

Introduction to Digital Photogrammetry - DEM and its Geological Applications Satellite Remote Sensing –Interaction with EMR - Geological applications of satellite data introduction to digital Image processing - Fundamentals of GIS. Vector data model: raster data model - Buffering. Overlay analysis – GIS applications for Geological studies.

Text /Reference Book

1. Dana,E.S.,(1955),Text book of Mineralogy, John Wiley., Deer,
2. Francis Rouessac and AnnickRouessac., (2007), Chemical Analysis (ModernInstrumentation Methods and Techniques) John Wiley & sons, 574p.,
3. Bathurst,R.G.C., (1972) Carbonates sediments and their diagenesis. ELBSPubications.
4. Benhardsen T. (2002) Geographic Information Systems: An Introduction,John Wiley Sons, New York.,
5. Dickin,A.P., (1995) Radiogenic Isotope Geology.
6. Drury S.A. (1993)Image Interpretation in Geology, Chapman & Hall Publications.
7. Keller,E.A., (1978), Environmental Geology,Merril.
8. Franklin W. Schwartz and Hunaozhang (2002).Fundamentals Ground Water John Wiley and New York.
9. Freeje and Cherry J.A. (1986) Ground Water Prentice Hall.
10. Gupta R.P. (2005),Remote Sensing in Geology, Springer Verlag Edition.
11. Haq,B.U.andBoerams A. (1978).Introduction to Marine Micropaleontology,Elsevier, New York,
12. Jones R.w. (1996).Micropaleonotology in Petroleum Exploration, CaarendonPress, Oxford
13. Karanth .K.R. (1987) Grounwater Assessment and Management, Tata McGraw Hill, New Delhi.
14. Kathal,P.K. (1998). Microfossils and their applications.CBS Publishers andDistributors, New Delhi.
15. Lillisand Kiefer R.W., (2000), Remote Sensing and Image Interpretation JohnWiley SMS, New York.
16. Miall A.D (2000)Principles of Sedimentary Basin Analysis. Springer-Verlag.
17. Montgomery,C.W., (1986).Environmental Geology, Wn.C,Brown Publishers.
18. Pettijohn,F.J., (1975)Sedimentary rocks Harper an drow.

19. Thompson,D.B and Collinson,D. (1989)Sedimentary structures.unwin Hyman.
20. Todd.D.K. (2003).Groundwater Hydrology, John Wiley and Sons, New York.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	2	1	2	3	2	1	2	2	2	3
CO 2	3	2	1	3	1	3	2	1	2	3	2	2
CO 3	3	3	2	2	2	3	2	2	2	3	2	3
CO 4	3	2	2	3	3	2	2	1	2	3	2	3
CO 5	3	2	3	3	3	3	2	1	2	3	2	3

Note: PEOs-Program Educational Objectives, POs -Program Outcomes and CO-Course Objective and Cognitive level: K1- Remembering, K2-Understanding& K3- Applying.

18MPAG03 GUIDE PAPER

PAPER III Optional Paper

1. STUDIES IN GEOMORPHOLOGY

Course objective

- To study the concept and principles of Geomorphology.
- To Study the weathering and fluvial geomorphic system.
- To understand the contrast between arid and humid regions.
- To study the Karst topography and its features.
- To learn about geomorphic subdivisions of India.

Course outcome

- To understand geomorphic processes and tectonic landforms.
- To identify processes and geometry of geomorphic system.
- Learning about different landforms.
- Understanding the concept in Karst and glacial landforms.
- This course also focuses on the applied geomorphology in engineering projects.

Unit I

Geomorphology: Definition, Scope of Geomorphology, Fundamental concept or Principles of geomorphology. Geomorphic Processes: Exogenic, Endogenic and extraterrestrial process. Tectonic Landforms: Tectonic scarps, fault scarps, fault-line scarps, landforms associated with strike-slip fault, fault valleys, fault block mountains, landforms made by folding.

Unit II

Weathering: Mechanical weathering and chemical weathering. Mass wasting and hill slope development. Fluvial Geomorphic System: overland flow and development of rills and gullies, channeled flow- processes and geometry, Flooding-frequency and magnitude, Sediment erosion and transport. Drainage basin evolution, deltas and alluvial fans.

Unit III

Contrast between arid and humid regions - Origin of deserts-arid erosion cycle. eolian processes and landforms: erosional landforms, eolian deposits and landforms. Shore-zone processes and landforms: wind waves, breakers and surf, tides and currents, wind. Shore platforms, coastal cliffs, coral reef morphology and classifications, Beaches.

Unit IV

Karst topography features: Terra rossa, lapies, sinkholes and associated features, natural tunnels and bridges, erosion remanants, caverns and

associated features. Karst geomorphic cycle. Glaciers: types of glaciers, Glacier erosional features: Cirque, glacial troughs, hanging valleys, serrate ridges, truncated spurs, Fjords. Depositional landforms: glacial forms, glacial-fluviatile forms, glacial-lacustrine features.

Unit V

Geomorphic subdivisions of Indian subcontinent, Himalayan landscape, Indo-Gangetic plains, Deccan Plateau, Coastal low lands. Applied Geomorphology: hydrological applications, exploratory tool for economic geology and applications in engineering projects.

Text /Reference Book

1. Bloom, A.L., 2003Geomorphology: A systematic Analysis of Late Cenozoic Landforms, Prentice Hall.

2. Thornbury, W.D., 2004 Principles of Geomorphology. 2nd edition. Wiley Eastern Ltd. New Delhi.

3. Richard Huggett 2007. Fundamentals of Geomorphology, 2nd Edition. Routledge N. Y.
4. Ritter,D.F., Kochel, R.C.,Miller, J.R., Process Geomorphology, Waveland press, 2002.
5. H.S. Sharma (1990) Indian Geomorphology.Concept Publication. Co., New Delhi.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	3	1	1	3	2	2	2	3	2	2
CO 2	3	3	1	2	1	3	3	1	2	3	2	3
CO 3	3	2	2	2	2	3	2	1	3	2	2	3
CO 4	3	2	3	3	3	3	2	1	2	3	3	3
CO 5	3	3	2	2	3	3	3	1	2	3	2	3

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18MPAG03 GUIDE PAPER

PAPER III Optional Paper

2. STRUCTURE AND TECTONICS

Course objectives:

- To understand the concept of stress and strain.
- To study the shear zones and geometry of thrust sheets.
- For emphasis the Foliations and Lineations.
- To understand the Plate tectonics.
- To understand the plate tectonics and its relation to rock types.

Course Outcome

- Knowledge of theelastic, plastic and viscous materials.
- Analytical ability on tectonic structures.
- Knowledge and skill on petrographic analysis.
- Knowledge and skill on plate boundaries.
- Knowledge onprocesses and mineralization of rocks.

Unit I

Concept of stress and strain: Stress-strain relationship of elastic, plastic and viscous materials, measurement of strain in deformed rocks, behaviour of minerals and rocks under deformation conditions. Folds: classification and causes of folding, diapirs and salt domes.

Unit II

Shear zones: Recognition of shear zones and faults in field, mechanics of shearing and faulting. Geometry of thrust sheets: Block faulted and rifted regions. Wrench faults and associated structures. Tectonic melanges, Dome and basin structures, Structural behavior of igneous rocks.

Unit III

Foliations and Lineations: classification, origin and significance. Petrofabric analysis (microfabrics): Data collection, plotting, symmetry and interpretation, concept of symmetry of fabric of tectonites. Geotectonics: Introduction, tectonic framework of earth's crust, interior of earth. isostasy, convection currents, Wilson Cycle.

Unit IV

Plate tectonics: Concept of plate and plate movements, plate model of Morgan, nature of convergent, divergent and conservative plate margins, transpression and transtension.

Unit V

Plate tectonics in relation to igneous, sedimentary and metamorphic processes and mineralization. Triple junctions, aulocogens, plume theory, island arcs. Nature and origin of earth's magnetic field.

Text /Reference Book

1. Belousov,V.V.(1968).Structural Geology, Mir Publishers.
2. Billing, M.P.(1972).Structural Geology, Prentice-Hall.
3. Condie, K.C.,(1976).Plate tectonics and Crustal evolution.
4. Davis,G.H., 1984.Structural Geology of Rocks and Regions. John Wiley & Sons.
5. De Sitter. L.U. (1956), Structural Geology, McGraw Hill, New York.
6. Ghosh S.K. (2013) Structural Geology: Fundamentals and Modern Developments, Pergamon Press
7. Hill. E.S. (1972), Elements of Structural Geology, John Wiley, New York
8. Hobbs, B.E., Means, W.D. and Williams, P.F. John Wiley, (1976) An outline of structural geology.
9. Park, R.G., (1983). Foundations of Structural Geology, Blackie and Sons Ltd.
10. Windley, B.F.,(1976).The Evolving Continents. Jhon Wiley and, New York.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	3	2	3	2	3	2	1	2	2	2	3
CO 2	3	2	2	1	1	3	3	1	1	3	2	3
CO 3	3	2	2	2	2	3	2	1	2	3	2	3
CO 4	3	3	1	2	3	3	2	1	2	3	2	3
CO 5	3	2	1	3	2	3	3	1	3	2	2	3

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective and Cognitive level: K1- Remembering, K2-Understanding& K3- Applying.

18MPAG03 GUIDE PAPER

PAPER III Optional Paper

3. PALAEONTOLOGY AND MICROPALAEONTOLOGY

Course objectives

- To get an idea on theories on the origin and evolutionary history of Life.
- To apply for Morphology, taxonomy, age, distribution and ecological niches of species.
- To emphasis the Evolutionary history of fossils.
- To understand the morphology, classification and evolution of foraminifera.
- To understand, the paleoenvironmental interpretation.

Course Outcome

- To understand the geological times scale, morphological classification and Nomenclature of species.
- To know about detailed history of ancient species.
- To identify the evolutionary history of recent species.
- To understand the paleoenvironment and past sea level changes using microfossils.
- To evaluate the sequence biostratigraphy.

Unit I

Definition of palaeontology. Theories on the origin and evolutionary history of Life. Fossilization process and the nature of fossil record. Definition for Species, index fossil, cosmopolitan species, fossil assemblage, fossil diversity, phylogeny. Types of biozones. Geological time scale. Morphological classification and Nomenclature. Cladistics. Species evolution, proliferation and extinction through time.

Unit II

Morphology, taxonomy, age, distribution and ecological niches of Anthozoa, Trilobita, Graptoloidea, Porifera, Bryozoa.Brachiopoda, Bivalvia, Gastropoda, Cephalopoda, and Echinoidea.

Unit III

Evolutionary history of Reptilian, Avian, Piscean, and Amphibian fauna. Evolution of mammals. Evolution of horse, elephant and human.Functional morphology.

Unit IV

A brief introduction to morphology, classification and evolution of foraminifera, dinoflagellates, spore and pollen, green and blue-green algae,

acritarchs; basic concepts in molecular micropaleontology. Reconstruction of paleoenvironment and past sea level changes using microfossils. Microfossil assemblages and stable isotopes in calcareous microfossils for paleoclimate interpretation.

Unit V

Palynofacies and paleoenvironmental interpretation.Cenozoic plankton biostratigraphy, larger foraminiferal zones and resolution of the stratigraphic records; Sequence biostratigraphy.Organic geochemistry of palynomorphs.Micropalaeontology in mineral and hydrocarbon exploration.

Text/Reference Books

1. Arnold.R (1947), An Introduction to Palaeobotany, McGraw Hill, New York
2. Arumugam (1989), Organic evolution, Sara Publication, Kanyakumari
3. Benton, M.J. and Harper, D.A.T., (2009) Introduction to Paleobiology and the fossil record. Wiley-Blackwell. London.
4. Clarkson E.N.K. (1986). Invertebrate paleontology and evolution. George Allen &Unwin.
5. Colbert, E. (1955), The Evolution of Vertebrates, John Wiley, New York.
6. Jain, P.C &Anantharaman, M.S (1996), Palaeontology, Evolution and Animal Distribution, Vishal Publications.
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9. Nield, E.W. and Tucker, V.C.T., (1985) Palaeontology: An introduction. Pergamon Press Ltd., Oxford.
10. Raup D.M. & Stanley (1985).Principles of paleontology.CBS Publ. & Distributors, New Delhi.
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12. Sherlock, R.R &Twenohofel, W.H (1953), Principles of Invertebrate Palaeontology,New York
13. Swinnerton, H.H (1961), Outlines of Palaeontology, Edward Arnold Publ. Ltd., London.
14. Armstrong, H.A. and Brasier, M.D. Microfossils, 2nd Edn., Blackwell Publishing, 2005
15. Travers, A. Paleopalynology, 2nd Edn., Springer, 2007
16. Jansonius, J. and McGregor, D.C. (Eds.) Palynology: Principles and Applications. AASP foundation, 1996
17. BouDagher-Fadel, M.K. Evolution and Geological Significance of Larger Benthic Foraminifera. Elsevier, The Netherlands, 2008

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	1	1	3	3	2	1	2	3	2	3
CO 2	3	2	1	1	1	3	2	1	2	3	2	3
CO 3	3	3	2	2	2	3	2	1	2	3	2	3
CO 4	3	3	2	1	2	3	2	1	2	3	2	3
CO 5	3	2	2	1	3	3	2	1	2	3	2	3

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective and Cognitive level: K1- Remembering, K2-Understanding& K3- Applying.

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PAPER III Optional Paper

4. STRATIGRAPHY AND SEDIMENTOLOGY

Course Objectives

- To understand the stratigraphic principles and approaches to measurement of geological time.
- To study the history, tectonics, life and paleogeography during the Paleozoic Era.
- To make the students to understand the Mesozoic stratigraphy.
- To understand the principles and development of sedimentology.
- To focus the classification of sedimentary basins.

Course Outcome

- Acquire knowledge on the Precambrian stratigraphic succession and its economic importance.
- Realize the importance of Gondwana stratigraphy.
- Learn the applications of Cretaceous-Tertiary boundary.
- Obtain the knowledge on sediment textures and classification of sediments.
- Learn the applications of Sedimentology for palaeoclimatic and palaeoenvironmental interpretation.

Unit I

Principles of Stratigraphy: Stratigraphic Principles and approaches to measurement of geological time. Recent developments in stratigraphic classification and Geological Time Scale. Categories of Stratigraphic Classification and concept of Litho, Bio and Chrono Stratigraphy. Stratigraphic correlations. Approaches to paleogeography. Precambrian stratigraphic succession and economic importance of Dharwar Supergroup, Aravalli Supergroup. Proterozoic stratigraphy of Cuddapah, Vindhyan, Delhi Supergroup and their equivalents. Precambrian-Cambrian boundary.

Unit II

Paleozoic stratigraphy: History, tectonics, life and paleogeography during the Paleozoic Era. Stratigraphic frame work and fossil contents of the Paleozoic rocks of India with special reference to Kashmir and Spiti.Permian-Triassic boundary. Gondwana stratigraphy: Concept, classification, sedimentation and paleoclimates, fauna, flora, age and economic potential of Gondwana Supergroup.

Unit III

Mesozoic stratigraphy: Classification, geographic distribution, lithologic characteristics, fauna and flora economic potential of Triassic, Jurassic and Cretaceous systems in principal basins of India with special reference to Triassic of Spiti, Jurassic of Kutch and Cretaceous of Tiruchirappalli. Deccan traps. Cretaceous-Tertiary boundary. Cenozoic stratigraphy: Classification, depositional characteristics, fauna and flora and economic potential of the Palaeogene, Neogene and Quaternary Systems with special reference to Siwalik Group, Assam-Arakan region, Andaman-Nicobar Islands and its equivalents. Himalayan orogeny.Quaternary deposits and their significance.Paleogene- Neogene and Neogene-Quaternary boundary.

Unit IV

Principles and Development of Sedimentology.Time and space in Sedimentology. Completeness of sedimentary record. Primary and indirect modes of data acquisition in Sedimentology. Rock cycle, Processes of sediment genesis, transport and deposition. Physical, chemical and biological sedimentary structures. Sediment textures and classification of sediments.Controlling factors of sedimentation. Facies concepts. Facies association, facies succession. Facies successions formed under various environments.

Unit V

Classification of sedimentary basins. Diagenesis of sediments – Stages, zones and environments of diagenesis. Compaction, Porosity types and evolution, cementation, neomorphism, dissolution-recrystallization, dolomitization, and silicification. Palaeocurrent, heavy mineral and clay mineral analyses for provenance and basin analysis. An overview on Sedimentary basins of India. Applications of Sedimentology for palaeoclimatic and palaeoenvironmental interpretation. Study of sedimentary geochemistry for understanding depositional and diagenetic processes.

Text / Reference Book

1. Dunbar, C.O. and Rodgers, J. (1957) Principles of Stratigraphy. John Wiley & Sons.
2. Doyle, P. & Bennett. M.R. (1996) Unlocking the Stratigraphic Record (John Wiley).
3. GSI Misc. Publn. No. 30. (2006) Geology and Mineral Resources of the States of India.
4. Krishnan, M.S. (1982) Geology of India and Burma. CBS Publishers, Delhi Naqvi,S.M. and Rogers, J.J.W. (1987) Precambrian Geology of India. Oxford University Press.
5. Pascoe, E.H.(1968) A Manual of the Geology of India & Burma (Vols.I-IV) Govt. of India Press, Delhi
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7. Ravindrakumar. (1985) Fundamentals of Historical Geology and Stratigraphy of India. Wiley Eastern Ltd., New Delhi.
8. Robert, M. S. (1989) Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York. ,
9. Wadia, D.N. (1998) Geology of India. Tata McGraw Hill, India
10. Collins J.D. and D.B. Thompson (1982) Sedimentary Structures. George Allen &Unwin, London.
11. Flugel, E.V., (2002) Microfacies analysis of limestones. Elsevier.
12. Leeder, M., 1999. Sedimentology and Sedimentary Basins. From Turbulence to Tectonics. Blackwell, Oxford, 592 pp
13. Lindholm, R., (1988) A practical approach to Sedimentology. Blackwell Publication.
15. Nicholls, G. (1999) Sedimentology and Stratigraphy. Wiley-Blackwell.
16. Pettijohn F.J. (1975) Sedimentary rocks. Harper and Row Publ., New Delhi.
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19. Tucker M.E. and V.P.Wright (1990) Carbonate Sedimentology. Blackwell Publication.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	3	1	1	1	3	2	1	2	3	2	2
CO 2	3	2	1	1	1	3	2	1	2	2	2	3
CO 3	3	1	3	3	2	3	2	1	2	3	2	3
CO 4	3	2	2	3	2	3	2	1	2	2	2	3
CO 5	3	2	3	3	3	3	2	1	2	3	2	3

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective and Cognitive level: K1- Remembering, K2-Understanding& K3- Applying.

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PAPER III Optional Paper

5. IGNEOUS AND METAMORPHIC PETROLOGY

Course objectives

- To learn the types, physical properties and chemical properties of igneous rocks.
- To interpret the magmatic differentiation.
- To understand the petrogenesis and field presence of various rock groups.
- To understand the basic concepts of metamorphism and metamorphic petrology.
- To assess the nomenclature studies of metamorphic rocks.

Course Outcome

- Describe the physical and chemical environments of melting in the lithosphere.
- Categorize the classification of igneous rocks.
- Identify the importance of variation diagrams and their usefulness in field studies.
- Analyze qualitative data of megascopic and microscopic studies in metamorphic rocks.
- Analyze the metamorphic phase diagrams and their applications.

Unit I

Magmas – types – physical properties – chemical properties of igneous rocks. Generation of magmas – causes of melting – tectonic – physical and chemical environments of melting in the lithosphere. Mantle plumes. Phase rule and practical and petrological importance of synthetic igneous systems of rocks.

Unit II

Magmatic differentiation - definition – mechanisms – applications – assimilations – field evidences and recognition. Bowen`s reaction principle – petrological and field significance – classification of igneous rocks – IUGS schemes – TAS schemes – CIPW normative scheme – practical field applications. Petrography – nomenclature and classification.

Unit III

Petrography – nomenclature – classification – petrogenesis and field presence of various rock groups. Basalts – Alkaline rocks – Ultra mafic rocks

– important basic and acid rocks. Variation diagrams and their usefulness in field studies.

Unit IV

General - basic concepts of metamorphism and metamorphic petrology. Properties of protoliths before metamorphic changes. Distribution - presence of metamorphic rocks on the surface and near surface environments. Causes and interpretation studies – megascopic _ microscopic of metamorphic rocks.

Unit V

Classification – schemes – nomenclature studies of metamorphic rocks. Metamorphic reactions - stabilisation reaction. Phase rule – applications – metamorphic systems. Understanding – mechanisms – applications of pressure – temperature and time – metamorphic systems. Metamorphic facies – metamorphic phase diagrams and their applications. Petrography – genesis – classification and nomenclature of various metamorphic rock groups.

Text / Reference Book

1. Winter, J.D. 2010. Principles of Igneous and Metamorphic Petrology. PHI, New Delhi.
2. Haung, W.T. 1962. Petrology, McGraw Hill, New York.
3. Williams, H et al. 1982. Petrography, CBS, New Delhi.
4. McBirney, A.R. 1993. Igneous Petrology, CBS, New Delhi.
5. Best, M.G. 2003. Igneous And Metamorphic Petrology, Wiley, New Delhi.
6. Winkler, H.G.F. 1970. Petrology of the Metamorphic Rocks. Springer, New Delhi.
7. Chaterjee, S.C. 1974. Petrography of the Igneous and Metamorphic rocks of India. Macmillan, Delhi.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	3	2	1	1	3	2	1	2	3	2	3
CO 2	3	2	1	3	1	3	2	2	2	3	2	3
CO 3	3	3	2	2	2	3	2	1	2	3	2	2
CO 4	3	2	3	3	3	3	2	2	2	3	2	3
CO 5	3	1	3	2	3	3	2	1	2	3	2	3

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective and Cognitive level: K1- Remembering, K2-Understanding& K3- Applying.

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PAPER III Optional Paper

6. ECONOMIC GEOLOGY

Course objectives

- To describe about the advances in economic geology.
- To Illustrate the Paragenesis and zoning in mineral deposits.
- To understand the mineralogy, mode of occurrences, uses and distribution in India of the metalliferous deposits.
- To study of non- metallic mineral deposits.
- To learn about the introduction to ore microscopy.

Course Outcome

- Predict the modern concepts of ore genesis
- Describe the ore forming processes.
- Analyze the metalliferous deposits.
- Assess the non-metallic mineral deposits with reference to geology, mode of occurrence, origin, uses and distribution in India.
- Discuss the ore texture and optical properties of common minerals.

Unit I

Advances in Economic Geology. Mode of occurrences and morphology of ore bodies and relationship with host rocks -Textures and Structures of ore and gangue minerals. Modern concepts of ore genesis. Fluid inclusions -Wall rock alteration. Geothermometry, and geobarometry.

Unit II

Paragenesis and zoning in mineral deposits-Metallogenetic Epochs and Provinces. Structural, physico-chemical and stratigraphic controls of ore localization. Study of ore forming processes- Orthomagmatic processes- Sedimentary processes- Metamorphic processes- Hydrothermal processes. Ore deposits in relation to plate tectonics.

Unit III

Mineralogy, mode of occurrence, uses and distribution in India of the following metalliferous deposits – Iron, Manganese, Aluminium, Copper, Gold, lead, Zinc – Chromium, Molybdenum, Rare Earth Group of metals(REE).

Unit IV

The study of non- metallic mineral deposits with reference to geology, mode of occurrence, origin, uses and distribution in India of Mica, Asbestos, Barytes, Gypsum, Limestone, Garnet, Corundum, Calcite, Quartz, Feldspar,

Clays, Kyanite, Sillimanite, Graphite, Talc, Fluorite, Beryl and Gem minerals.

Unit V

Introduction to ore microscopy, techniques, methods, textures and microstructures of ores, interpretation of ore texture and optical properties of common sulphide, oxide ore minerals, Industrial application of ore microscopy.

Text / Reference Book

1. Anthony Evans, (1993) Ore Geology and Industrial Mineral, John Wiley & sons, USA.
2. Bateman Allan .M. (1962) Economic Mineral Deposits, Asian Publishing House, 2nd Edition.
3. Coggin, B. and Dey, A.K. (1955) India's Mineral Wealth, oup.
4. Craig, J.M. & Vaughan, D.J., (1981): ore Petrography and Mineralogy. John Wiley
5. Cuilbert, J.M. and Park, Jr. C.F.(1986): The Geology of Ore Deposits, Freidman.
6. Deb.S. (1980) Industrial Minerals and Rocks of India, Allied.
7. Edwards, R. and Atkinson, K. (1986) Ore deposit geology, Ist Edition, Chapman and Hall. New Delhi,.
8. Evans, A.M. (1993): Ore Geology and Industrial Minerals, Blackwell.
9. Gokhale, K.V.G.K. and Rao , T.C (1978)- Ore deposits of India, their distribution and processing, Thosmson press,.
10. James R. Craig and David J.Vaughan (1994): Ore Microscopy and Petrography.
11. Jansen M.L. & Bateman A.M.: (1981), Economic Mineral Deposits, John Wiley & Sons, Singapore.
12. Klemm, D.D. and Schnieder, H.J. (1977): Time and Strata Bound Ore Deposits, Springer-Verlag.
13. Krishnaswamy ,S. - India's Mineral Resources, oxford and IBH.
14. Lindgren W. (1933)Mineral Deposits, MCGraw Hill,.
15. Mukherjee, A. (2000): Ore Genesis-A Holistic Approach, Allied Publishers.
16. Park, C.F. and Macdiarmid, R.A (1970) Ore deposits, Freeman,
17. R.M. Umathay, (2006)Mineral Deposits of India, Dattsons, New Delhi, India,
18. Ramdhor, P. (1969): The Ore Minerals and their Intergowths, Pergamon Press.
19. Robb, L. (2005)Introduction to ore-forming processes, Blackwell publishing, U.K.,.
20. Stanton, R.L. (1972): Ore Petrology, McGraw Hill.
21. Wolf, K.H. (1976-1981): Hand Book of Stratabound and Stratiform Ore Deposits, Elsevier Publ
22. Meher,D.N. Wadia, (1994), Mineral of India, National Book Trust, New Delhi.

23. Sinha.R.K and Sharma.N.L.(1970), Mineral Economics, Oxford IBH Publishing Co.,New Delhi.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	3	1	2	1	3	2	1	2	3	2	2
CO 2	3	2	1	1	1	3	2	1	2	3	2	3
CO 3	3	2	2	2	2	3	2	1	2	3	2	3
CO 4	3	2	3	3	3	3	2	1	2	3	2	3
CO 5	3	3	2	3	2	3	2	1	2	2	3	3

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective and Cognitive level: K1- Remembering, K2-Understanding& K3- Applying.

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PAPER III Optional Paper

7. ENVIRONMENTAL GEOLOGY

Course objectives:

- To understand the concepts of environmental geology.
- To assess the soil and environment.
- To learn about the Mining and the environment.
- To build knowledge about the Geology and construction material.
- To demonstrate about the natural geo hazards.

Course Outcome

- An overview of ecosystem and climate.
- Analysis of renewable and non-renewable resources.
- Explain the human interaction with environment.
- Describe the Geology and construction.
- Explain the Environmental legislation law.

Unit I

Concepts of Environmental Geology, Domains of Environmental Geology, Global changes in the ecosystem, Sea level changes, Ocean on climate and rainfall, Global warming, Ozone layers, Cosmic rays and its impact, Time scales of global changes in the ecosystem and climate, Levels of Present and past atmospheric carbon-dioxides, Geological hazards and planning, Risk assessment, Hazards mapping.

Unit II

Soil and environment, Origin of soil, Soil horizons, Pedological soil types, Soil Capability studies, Soil erosion and controlling measures, Soil conservation practices, Desertification, Afforestation, Forest fire, Human interaction with environment, Conflict between human and wild animals, Geology with environmental health, Waste disposal, Energy and environment, Renewable and non-renewable resources, Ocean resources, Coastal erosion and preventive measures, Environmental law.

Unit III

Mining and the environment: Surface mining, Waste materials from mining, Acid mine drainage, Coal mine effluent, Heap leaching, Spontaneous combustion, Gases, Mineral dust, Contamination due to mining. Domestic reuse and sanitary landfills, Hazardous waste, Radioactive waste and disposal, Industrial toxic material disposal, Energy and Environment, Renewable and non-renewable energy, Geothermal energy, Wind and tidal energy.

Unit IV

Geology and construction material, Gravels and sand, Mud rocks and brick manufacturing, Special type of clay, Building and dimensional stone, Roofing and facade materials, Concretes, Road aggregates, Armor stone, Cement, Lime and plaster, Geology and construction, Tunnels and tunneling, Shaft and Raises, Highways, Embankments, Rail roads, Bridges, Foundation for buildings.

Unit V

Natural geo hazards: Volcanic activity, Earthquakes, Slope measurement and stability, River erosion and flooding, Marine action, Wind action and arid regions, Glacial Hazards, Dissolution of rocks, Gases, Basic hydrology, Reservoirs, Dam sites, Water wells, Gas well and oil wells, Environmental legislation law.

Text / Reference Book

1. Valdiya, K.S. (1987) Environmental Geology – Indian Context. Tata McGraw Hill
2. Keller, E.A. (1978) Environmental Geology, Bell and Howell, USA
3. Bryant, E. (1985) Natural Hazards, Cambridge University Press
4. Patwardhan, A.M. (1999) The Dynamic Earth System. Prentice Hall
5. Subramaniam, V. (2001) Textbook in Environmental Science, Narosa international.
6. Bell, F.G. (1999) Geological Hazards, Routledge, London
7. Smith, K. (1992) Environmental Hazards. Routledge, London

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	1	1	1	3	2	1	2	3	2	3
CO 2	3	2	1	1	1	3	2	1	2	3	2	3
CO 3	3	2	2	2	2	3	2	1	2	3	2	3
CO 4	3	2	3	3	3	3	2	1	2	3	2	3
CO 5	3	2	3	3	3	3	2	1	2	3	2	3

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective and Cognitive level: K1- Remembering, K2-Understanding& K3- Applying.

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PAPER III Optional Paper

8. TRENDS IN HYDROGEOLOGY

Course objectives

- To Illustrate about the hydrologic cycle and processes.
- To know in detail Groundwater flow.
- To understand the quality of Groundwater.
- To know in detail about the construction, design and performance of wells.
- To introduce about the Artificial Recharge methods.

Course Outcome

- Describe the storage and conduit functions of rocks.
- Evaluation of aquifer properties.
- Formulate the salt water intrusion.
- Evaluate the Groundwater exploration.
- Predict the Groundwater resources evaluation in India.

Unit I

Hydrologic Cycle and Processes: Precipitation, Evaporation and transpiration, Runoff, Infiltration, Water balance. Storage and conduit Functions of Rocks: Water bearing properties of rocks, Retention of water in rocks, Yield of water from rocks. Vertical distribution of groundwater: Zones of aeration, Zones of saturation, Storage coefficient of aquifers, Fluctuation of the water table, Fluctuation of the piezometric surface, Recharge and discharge areas.

Unit II

Groundwater Flow: Properties of water in relation to flow, Head distribution, Laminar and turbulent flow, Darcy's law, Base flow, Effluent stream flow, Influent stream flow. Evaluation of Aquifer Properties: Aquifer tests, Confined aquifers, Semi confined aquifers, Unconfined and Semi confined aquifers, Transition from artesian to water table conditions, A general layout of pumping test and its applications.

Unit III

Quality of Groundwater: Bacteriological quality, Chemical quality, Salinization quality, Physical quality, Diagrammatic representation of geochemical data, Groundwater pollution and its contamination, Use of water quality in mineral prospecting. Salt water Intrusion: Salinity influx in estuaries, Ghyben-Herzberg's relation, Zone of diffusion, Slope, shape and movement of interface, Groundwater extraction and intrusion, Identification of salt water zone and interfaces, Prevention and control of salt water intrusion i. Observation wells and its functions.

Unit IV

Construction, Design and Performance of Wells: Types of wells and methods of construction, Tube well design, Well development, Maintenance and revitalization of wells, Water yield in Dug well versus tube well. Geomorphic controls, Geologic controls, Groundwater provinces of India, Hydrogeochemical provinces of India. Groundwater Exploration: Geologic and hydrogeologic methods, Hydrogeologic well logging, Geophysical well logging, Tracers techniques.

Unit V

Artificial Recharge: Spreading methods, Induced recharge method, Recharge well method, Subsurface dams, Waste water recharge, Recharge by urban storm runoff. Groundwater Recharge, Discharge and Balance: Parameters of groundwater balances, Estimation of recharge components, Estimation of groundwater discharge, Groundwater resources evaluation in India. Surface and subsurface groundwater exploration techniques.

Text / Reference Book

1. Todd, D.K., (1980), Groundwater Hydrology-John Wiley & sons publishers, New York, 535p.
2. Davies, S.N. and De Wiest, D.R., (1966), Hydrogeology-John Wiley& sons, Inc, New York,463p.
3. Freeze, R.A. and John,A., (1979), Groundwater, Cherry, Prentice Hall,Inc,604p
4. Fetter, C.W., (1990), Applied Hydrogeology-Mc Graw Hill, Publisher, New Delhi.
5. Raghunath, H.M., (2007), Groundwater 3rd edition,New Age International Publishers,520p.
6. Karanth, K.R., (1987), Groundwater Assessment, Development and Management-Tata McGraw Hill New Delhi 720p
7. Alley, W.M., (1993), Regional Groundwater Quality-VNR, New York
8. Subramaniam, V., (2000), Water-Kingston Publ. London

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	1	2	1	3	3	2	1	2	3	2	3
CO 2	3	2	1	1	1	3	2	1	2	3	1	3
CO 3	3	3	1	2	2	3	2	2	2	3	2	3
CO 4	3	2	3	3	3	3	2	1	2	3	2	3
CO 5	3	2	3	3	3	3	2	3	2	3	3	3

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective and Cognitive level: K1- Remembering, K2-Understanding& K3- Applying.

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PAPER III Optional Paper

9. APPLIED GEOPHYSICS AND GEOCHEMISTRY

Course objectives

- To understand the principles, concepts, instrumentation and field application of geophysics.
- To acquire knowledge about the Gravity methods.
- For emphasis the Magnetic methods.
- To understand the Seismic methods.
- To understand the elemental abundance of earth materials.

Course Outcome

- Describe the basics of electrical properties of rocks.
- To explain the application and limitations of gravity methods.
- Assess the Electromagnetic methods and their applications.
- Discuss the application and limitations of seismic methods.
- Knowledge on the Geobotanical methods and their applications.

Unit I

Principles–concepts–instrumentation–field application–geophysics. Electrical Methods: Laws–definitions. Electrical properties of rocks–minerals. Equipments – methods – field – data acquisition – processing – interpretation. Application and limitations of electrical methods. Geophysical well logging methods. Principles – concepts – instrumentation – field application – limitations. Types of logging. Equipments – methods – field – data acquisition – processing – interpretation.

Unit II

Gravity methods: Laws – definitions. Gravity anomaly properties of rocks – minerals. Equipment's – methods – field profiling – data acquisition – processing – interpretation. Application and limitations of gravity methods.

Unit III

Magnetic Methods: Components of earth`s magnetic field. Magnetic character of rocks and minerals. Equipments – methods – field – data acquisition – processing – interpretation. Magnetic contour maps – preparation and application.Aero magnetic data and its applications. Electromagnetic methods and their applications. Telluric and magneto telluric applications and limitations.

Unit IV

Seismic Methods: General Principles. Methods – seismic properties of rocks. Laws – definitions - Equipments – methods – field – data acquisition – processing – interpretation. Application and limitations of seismic methods. Refraction and Reflection methods – differences - Equipments – methods – field – data acquisition – processing – interpretation.

Unit V

Elemental abundance of earth materials. Geochemical classification. Concepts – geochemical cycles – dispersion – controls and mobility of elements – haloes – types and recognition – utility of path finder elements. Geochemical surveys – exploration - principles – instruments – sampling methods – types. Geochemical analysis – principles – methods – instrumentation – limitations – interpretations. Geobotanical methods and their applications.

Text / Reference Book

1. RamachandraRao, M.B. 1993. Outlines of Geophysical Prospecting. EBD, Dhanbad.
2. Kearey, P., Brooks, M & Hill. I. 2002. An introduction to geophysical exploration, 3rd ed. Blackwell Science.
3. Telford, W.M., Geldart, L.P & Sheriff, R.E. 1990. Applied Geophysics. 2nd ed. Cambridge University Press, New Delhi.
4. Parasnis, D.S. 1975. Principles of applied Geophysics.Chapman & Hall.NewYork.
5. Dobrin, M.B. &Savit, C.H. 1988. Introduction to Geophysical Prospecting.4th Ed. McGraw Hill, New Delhi.
6. Hawkes,H.E. 1959. Principles of Geochemical Prospecting.Bulletin 1000F.USGS.
7. Arogyasamy, R.N.P. 1980. Courses in Mining Geology.Oxford & IBH, New Delhi.
8. Moon, C.J., Whateley, M.K.G. & Evans, A.M. 2006. Introduction to Mineral Exploration. Wiley Blackwell. New Delhi.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	3	2	1	2	3	2	1	2	3	2	3
CO 2	3	2	1	1	1	3	2	1	2	1	2	3
CO 3	3	3	2	2	3	3	3	1	2	3	3	3
CO 4	3	2	1	3	3	3	2	1	2	3	2	3
CO 5	3	3	2	3	3	3	2	1	2	3	2	3

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective and Cognitive level: K1- Remembering, K2-Understanding& K3- Applying.

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PAPER III Optional Paper

10. REMOTE SENSING AND GIS IN GEOLOGY

Course objectives:

- To understand the concept and scope of Electromagnetic spectrum.
- To assess the Digital image processing.
- To attain the GIS components.
- To assess the GIS data input.
- To acquire knowledge about the remote sensing and GIS applications.

Course Outcome

- Assess the basics of remote sensing satellite.
- Explain the concept of digital image processing.
- Analyze the vector and raster data in GIS.
- Explain the spatial data analysis.
- Describe the natural disaster mapping.

Unit I

Electromagnetic radiation spectrum, EMR interaction with atomosphere, EMR interaction with earth objects, Spectra of rocks and Minerals, Landsat satellite programme, Indian Remote sensing satellite (IRS) programme, Introduction to hyperspectral remote sensing, Hyperspectral remote sensing data.

Unit II

Digital image processing: Introduction, geometric and radiometric errors, geometric and radiometric corrections, image enhancement techniques, Band rationing techniques, principal component analysis, unsupervised classifications, supervised classifications and fuzzy classifications.

Unit III

Definition of GIS, GIS components, Vector data model, raster data model, attribute data, Spatial data structure - non topology (spaghetti) structure, topology data structure, Raster data structure- Quad tree model, run-length encoding, Vector to Raster conversion, Data base management system.

Unit IV

GIS data input – data sources, map projections, digitizing, coordinate conversion. Spatial data query- display, visualization, spatial query. Spatial data transformation, spatial data analysis- logical and arithmetic operations, Map overlay analysis, Remote sensing and GIS Applications: Geomorphology and landforms studies.

Unit V

Remote sensing and GIS Applications: Petroleum and Mineral exploration, Groundwater exploration, artificial recharge and groundwater management, Engineering Geological investigations, Natural disaster mapping (landslide & flooding), structure and tectonic studies, coastal zone mapping and management.

Text / Reference Book

1. Lillisand, T.M., & P.W.Kiefer., (2000). Remote sensing and Image Interpretation, John Wiley & Sons, Inc. New York. P 724.
2. Gupta, R.P. (2000) Remote Sensing Geology. Springer-Verlag. 356pp.
3. Jensen.J.R., (2005) Introductory to Digital image processing, 3rd edition, Pearson Prentice Hall, p526.
4. Anbazhagan .S, Subramanian.S.K, and Yang Xiaojun (2011) ed., al: Geoinformatics in Applied Geomorphology. CRC Press, Taylor & Francis Group, FL p383.
5. Campbell, J. B. (1996) Introduction to Remote Sensing.622pp.
6. Drury, S.A. 1987. Image interpretation in Geology.Chapman and Hall.
7. Chang. K T 2002. Introduction to Geographic Information Systems, Tata McGraw-Hill 348p
8. Burrough P.A., and McDonnell.R.A., (1998). Principles of Geographic Information System. Oxford University Press, P333.
9. Sabins,F.F.Jr (1978) Remote sensing Principles and Interpretation, Freeman,sanfrancisco sons, New York.
10. Tor Bernhardsen; Geographic Information Systems –An Introduction – John Wiley & Sons.
11. Bonham Carter, G.F. 1994. GIS for Geoscientists- Modelling with GIS, Elsevier, p 398.

Outcome Mapping

POs& PSOs/COs	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO 1	3	2	1	2	1	3	2	1	2	3	2	3
CO 2	3	3	2	1	1	3	2	1	2	3	3	3
CO 3	3	2	2	2	2	3	2	1	2	3	2	3
CO 4	3	2	3	3	2	3	2	1	2	3	2	3
CO 5	3	2	3	3	2	3	2	1	2	3	2	3

Note: POs-Program Outcomes, PSOs -Program Specific Outcomes and CO-Course Objective and Cognitive level: K1- Remembering, K2-Understanding& K3- Applying.
