

# Maharshi Dayanand University Rohtak



## Ordinances, Syllabus and Courses of Reading for Geology M. Sc. (Previous) Examination

Session—1997-98

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*Available from :*

Deputy Registrar (Publication)  
Maharshi Dayanand University  
Rohtak-124001 (Haryana)

*Price :*

At the Counter : Rs. 20/-  
By Regd. Parcel : Rs. 30/-  
By Ordinary Post : Rs. 25/-

## **ORDINANCE - 'MASTER OF SCIENCE EXAMINATION'**

1. The Master of Science Examination shall be held in two parts. Part-I Examination shall be held at the end of the first year and Part-II Examination at the end of the second year.
2. The Examination in Part-I and Part-II shall be held once a year ordinarily in the month of April on such dates as may be fixed by the Vice-Chancellor.

A supplementary examination in Part-II of M.Sc. will be held in December for those candidates who have passed all the papers of Part-I examination but have got 'reappear' or have failed or want to improve their score in paper(s) of part-II examination. However, total number of chances will not exceed as given in the Ordinance.

3. The last date for the receipt of admission form and fee without late fee as fixed by the Vice-Chancellor shall be notified to the Heads of the University Teaching Departments and the Colleges concerned.
4. A candidate's admission form and fee may be accepted after the last date on payment of Rs. 105/- up to the date notified by the University.

No late fee shall be charged if the admission form and fee are received within three working days of grace after the last date for the receipt of the same without late fee.

5. No one shall be eligible to join the first year (Part-I) class of M.Sc. Course unless he has passed one of the following examination:-

- a) B.Sc. (Hons.) examination of this University with atleast 45% marks in the aggregate in the subject offered for the M.Sc. Course.
- b) B.Sc. (Pass) examination with atleast 50% marks in the aggregate.
- c) An examination of any other university recognised by the University as equivalent to (a) or (b) above.

Provided that:

- i) to be eligible to join M.Sc. Course in Physics, a candidate must have passed B.Sc. Examination with Physics and Mathematics as two of the main subjects;

- ii) to be eligible to join M.Sc. Chemistry, a candidate must have passed B.Sc. Examination with Chemistry as one of the main subject.

**Note:** A Minimum of 25% of the total seats shall be filled in by the students who have passed the B.Sc. Examination with Chemistry, Physics and Mathematics. Any seat remaining unfilled out of this quota may be offered to other eligible candidates.

- iii) to be eligible to join M.Sc. course in Bio-Science, a candidate must have passed B.Sc. Examination with Botony, Zoology, Bio-Sciences and any one of the subjects viz. Chemistry, Bio-Chemistry, Micro-Biology Fisheries and Geology.

**Note:** The candidates will be required to opt for Animal Sciences or Plant Sciences or Environmental Biology in M.Sc. final course which will be allowed after taking into consideration the performance of the candidate in M.Sc. previous examination. However, an indication to this effect will be required to be given by the candidate at the time of his admission.

- iv) conditions for admission to M.Sc. Course in Mathematics shall be same as prescribed for admission viz. M.A. Course in this subject.
- v) To be eligible to join M.Sc. Course in Geology, a candidate must have passed B.Sc. Examination with atleast 50% marks in the aggregate with Geology and any of two of the subjects viz. Physics, Mathematics, Chemistry Botony, Zoology, Bio-Science and Geography;
- vi) to be eligible to join M.Sc. Course in Mathematical Statistics and Operations Research a candidate must have passed B.A./B.Sc. (Pass) Examination with atleast 50% marks in the aggregate with Mathematics or Statistics as one of the subjects or have passed B.A./B.Sc. (Hons.) Examination in Mathematics or Statistics with atleast 45% marks in Mathematics/Statistics.

There shall be a Project Report in M.Sc. Mathematical Statistics (Final) and that the project report shall be evaluated by the external examiner on five point grading. The last date for submission of Project Report will be two months after the theory papers which can be extended further by two months

with the permission of the Vice-Chancellor.

**Note :** *A candidate who is placed under compartment in the qualifying Examination shall not be allowed to join M.Sc. Course. He/She will be eligible only after clearing the qualifying Examination.*

- 6.1 A candidate who has failed in one or more papers or fails to appear in the examination shall be allowed two additional subsequent chances only to pass the examination.
- 6.2 A candidate who fails to pass the M.Sc. examination within a period of four years of his admission to the course shall be deemed to be unfit for postgraduate studies in the subject concerned.
- 6.3 A person who has passed the M.Sc. (Previous) examination in the subject concerned from this University shall be eligible to join the M.Sc. final class. This is subject to Clause-6.2 above. However, the candidates who have passed atleast two theory papers out of four or five theory papers or atleast three theory papers out of six or seven theory papers of part-I examination of this University will be promoted to Part-II Class, provisionally.
7. M.Sc. Examination in Part-I/Part-II shall be open to a student who:-
  - a) has passed the requisite qualifying Examination or is covered under Clause-6 and
  - b) has his name submitted to the Controller of Examinations by the Head of the University Department/Principal of the College, he has most recently attended and produces the following certificates signed by him:-
    - i) of possessing good character;
    - ii) of having remained on the rolls of the Department/College, during the year preceding the Examination;
    - iii) of having attended not less than 65% of full course of lectures and tutorial separately and 75% of practicals in each part (the course to be counted upto the last day when the classes break up for the preparatory holidays).
8. A candidate whether a regular student or an ex-student shall submit his admission application to the Registrar/Controller of Examinations duly signed by the Principal of the College/Head

of the University Department he has last attended.

9. Every candidate shall be examined according to the Scheme of examination and syllabus as approved by the Academic Council from time to time.
10. The amount of Examination fee to be paid by a candidate for each part shall be as follows:-

Regular student	Ex-student
Rs. 100/-	Rs. 110/-

**Note:-** Plus Rs. 20/- per practical subject.

*A candidate who re-appears in one or more theory or practical papers for the purpose of passing the examination or a candidate who appears in one or more theory papers for the purpose of improvement of score of marks/result shall pay fee as for the whole examination.*

11. The medium of instructions and examination shall be English.
- 12.1. The minimum number of marks required to pass the examination shall be as under:-
  - i) 33% in each paper (written and practical) separately;
  - ii) 40% in dissertation/Viva-voce where prescribed;
  - iii) 40% in the aggregate.
- 12.2. A candidate who has completed the prescribed course of instructions in a College/University Teaching Department for Previous/Final examination but has not appeared in it or have appeared fails may be allowed on the recommendation of the Principal of the College/Head of University Teaching Department concerned to appear in the subsequent years in the examination paper(s) as the cases may be without attending a fresh course of instructions while re-appearing in the examination, the candidate shall be exempted from re-appearing in the paper(s) and/or practical(s) in which he has obtained atleast 40% marks.
13. As soon as possible, after the termination of the examination the Registrar/Controller of Examinations shall publish the result of the Candidates and issue Detailed Marks Card.
14. The result of candidates who have passed M.Sc. examination shall be classified into divisions, as under and the division obtained by the candidate will be stated in his degree.

- a) Those who obtain 60% or more marks First Division
- b) Those who obtain 50% or more but less than 60% marks Second Division
- c) All below 50% Third Division

15.1 A candidate who has passed M.Sc. Previous examination, with atleast 55% marks may offer dissertation wherever prescribed in the Scheme of examination for the course. The subject of dissertation shall to approved by the Head of Department concerned. A candidate shall submit to the Head of the University Department an application for the approval of the topic for the dissertation alongwith a synopsis within one month of his admission to M.Sc. (Final) examination.

Provided in the case of M.Sc. (Geology) exam. there shall be a dissertation based on days field work (surface mapping) in the M.Sc. Previous. The work of dissertation will be done in the M.Sc. previous and viva-voce examination of dissertation will be held at the end of M.Sc. previous alongwith practical examination. Provided further that the condition of obtaining 55% marks in M.Sc. previous examination, for offering dissertation in M.Sc. final shall not be applicable in the case of students of M.Sc. (Geology) course.

15.2 Every candidate who offers dissertation shall be required to submit three copies of his dissertation alongwith a brief abstract of the same giving an account of the Investigation research conducted and its main findings (which will not exceed 500 words). The dissertation shall be examined by one external examiner only.

15.3 The last date for receipt of the dissertation in the office of the Controller of Examinations shall be one month before the commencement of the theory examination: Provided that in exceptional cases; the Vice-Chancellor shall have the power to extend, on the recommendation of the Head of the Department the last date for receipt of the dissertation upto three months. If a candidate fails to submit the dissertation even during the extended period he will be considered to have absented in the dissertation paper and his result shall be declared accordingly.

15.4 A candidate who has submitted a dissertation as part of his examination may withdraw the same before it has been

examined but once it is examined and the candidate obtains the minimum pass marks he shall not be permitted to withdraw it or submit another dissertation in lieu thereof. The marks obtained by him for the dissertation shall be taken into account when he appears in any future examination for the purpose of passing therein or for improving score of marks/result.

16. A candidate who has already passed the Master of Science examination from this University, in a subject in which different optional papers are permitted, may appear in one or more optional paper(s) of that subject at an subsequent examination when held as a regular student only. The examination fee shall be Rs. 35/- each paper.

Such a candidate shall in order to pass, be required to obtain atleast 40% marks in each paper in theory and practical separately.

- 17.1 A person who has passed the M.Sc. previous examinations of this University will be allowed to appear as an ex-student in the M.Sc. previous examinations for improvement alongwith M.Sc. final examinations respectively, only once, in one or more theory paper(s) within a period of 3 years of passing M.Sc. previous examination.

A person who has passed the M.Sc. examination of this University, and desirous of improving his score of marks will be allowed to appear as an ex-student in the M.Sc. final examinations, for improvement only once in one or more theory paper(s) within a period of two years of his passing the M.Sc. examination. In all a candidate will be allowed to avail one chance within the period specified above. Improvement in practical paper is not permissible.

The result of such a candidate shall be declared only if he improves his score of marks, by taking into account the marks obtained by him in the paper(s) in which he re-appeared and the marks obtained by him earlier in the remaining paper(s). The fact that the candidate has improved the division shall be mentioned in the Detail Marks Cards. If a candidate opts to appear in both previous and final examinations for the purpose of improvement but finds that he has improved the score of marks obtained by him in the previous examination, he may not appear in the final examination as the case may be and

inform the Controller of Examinations for the declaration of his result.

Provided further that the candidate will take the examination according to the syllabus in force for the regular students for that examination. Provided that the syllabus for the candidates for the special examination to be held in September/October shall be the same as was in force for the regular student in the last annual examination.

18. Notwithstanding the integrated nature of this course which is spread over more than one academic year, the Ordinance in force at the time a student joins the course shall held good only for the examination held during or at the end of the academic year and nothing in this ordinance shall be deemed to debar the University from amending the Ordinance and the amended Ordinance, if any, shall apply to all students whether old or new.
19. Candidate admitted to M.Sc. Course in 1990-91 or earlier shall be governed by the old rules. The new rules shall be applicable w.e.f. the admission of academic Session 1991-92.

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## SCHEME OF EXAMINATIONS

### M.Sc. (GEOLOGY) TWO YEARS COURSE

#### M.Sc Part-I (Geology)

It will be a two years course, in M.Sc. Part-I, the candidate will have to study the following compulsory papers:

		Max. Marks	Teaching Hrs. per week
Paper-I	Geomorphology	80	4
Paper-II	Structural Geology	80	4
Paper-III	Crystallography & Minerology	80	4
Paper-IV	Petrology (Igneous & Metamorphic)	80	4
Paper-V	Practical Structural Geology	50	$4\frac{1}{2}$
Paper-VI	Practical Crystallography and Minerology	50	$4\frac{1}{2}$
Paper-VII	Practical Petrology	50	$4\frac{1}{2}$
Paper-VIII	Dissertation	30	-

#### M.Sc. Part-II (Geology)

In M.Sc. Part-II, the candidate will study three compulsory papers (IX, X, XI) and one optional paper XII:-

Paper-IX	Stratigraphy & Palaeontology	80	4
Paper-X	Economic Geology	80	4
Paper-XI	Engineering Geology & Hydrology	80	4
Paper-XII (Optional)		80	4

The candidate will opt. for one of the following papers :

- i) Mining Geology and Geophysical Prospecting
- ii) Advanced Tectonics and Himalyan Geology.
- iii) Applied Sedimentology & Petroleum Geology
- iv) Applied Micropalaentology.
- v) Mineral Economics and Ore processing.

**Practicals:**

Paper-XIII	Practical Economic Geology	50	$4\frac{1}{2}$
Paper-XIV	Practical Geology and Hydrology	50	$4\frac{1}{2}$
Paper-XV	Dissertation	80	$4\frac{1}{2}$

**Paper-I Geomorphology**

Max. Marks : 80  
Time Allowed : 3 hrs.

**Section-A**

**Facts and figures regarding the shape and size of the earth. Origin of the earth: a general review of all the theories put forward up to date.**

**Age of the earth: the various methods of age determination, doctrine of uniformitarianism, sedimentation and salinity methods, Kelvin's physical methods, Palaeontological evolution method, modern methods based on the disintegration of uranium, thorium, actinium, rubidium, potassium and radio carbon.**

**Interior of the earth : general survey of the various views regarding the internal constitution of the earth since F.E.Suess; evidence from density and temperature, geological and physiographic evidence, evidence from seismology; the various discontinuities in the earth shells; the earth's magnetism.**

**Isostasy: definition, development of the idea through Bouger Petit, Airy, Hall, Jamieson and Dutton and recent investigations by Heiskanen, Bowie and Hayford; measurement of gravity, gravity anomalies, isostatic compensation, isostasy in India.**

**Geological processes acting on the earth's surface: Land forms, Products of rock destruction, residual and transported soils, weathering erosion and denudation.**

**SECTION-B**

**The atmosphere: its movements, changes in temperature and the physical effects, chemical work of the atmosphere, wind; its**

geological action, erosional transportation and depositional features, aeolian deposits; applied aspects such as engineering problems in loess and sand dune areas.

**Glaciers:** types and movement of glaciers, erosion, transportation and deposition and the resulting geomorphology, surface features, moraines, glaciated valleys; origin of glaciers, glacial soils, drift; unstratified glacial deposits, stratified glacial deposits; engineering problems in glacial zones; frost and permafrost; definition and origin, basic features, Soils.

**Oceans:** Geological function of oceans and deposition as a continuous process along the shore line, Shore lines and beaches, shorelines of submergence and emergence and relative nomenclature; beaches classified, waves, currents, tides; destruction of shore lines, littoral processes, destruction of shore cliffs and steep banks, submarine canyons.

**Coral Reefs:** Types of coral reefs, characteristics, optimum requirements for their development, theories on the origin of coral reefs.

**Hydrological Cycle :** rainfall and run-off, features of rain erosion, rain fall measurements, rain fall in India.

### SECTION-C

**Rivers:** erosion, transportation and deposition and the related geomorphology, growth and development of river systems, drainage, valley formation, erosion cycle, river terraces, flood plains and deltas, drowning, meandering, rejuvenation and piracy in rivers, alluvial soils; applied aspects such as the engineering significance of alluvial deposits.

Elements of sedimentation engineering; source of sediment in a river, mechanics of sediment transportation, kinds of sediments in a river, derivation of stream borne sediment; siltsurvey in rivers, sedimentation in channels, reservoirs; irrigation channels.

**Ground Water:** Sources of groundwater, types of groundwater, the water table and the pressure surface and its related zones, erosion transportation and deposition and the resulting features springs, wells, artesian wells; geysers and fumaroles.

**Landslides:** Landslides and crustal displacement; Types of slides, causes and effects of slides, rock falls and rock slides, creep, earth flow, subsidence.

**Volcanology** Volcanic phenomena, theories of volcanism, distribution of volcanoes in the world.

**Seismology:** definition of earthquakes; classification of earthquakes, causes, effects and mechanism of earthquakes, types of earth quake waves, velocity, magnitude and frequency, acceleration of groundwaves, foreshocks and after shocks, construction of a simple seismograph, interpretation of seismograms, intensity scales; distribution of earthquakes, earthquake belts of the world, effects of earthquakes on engineering structures, seismic building design earthquakes in India, the structure of the earthquake zones of India, geological investigation of earthquakes.

**Lakes:** description, bogs, swamps, muskegs; origin of lakes; engineering problems; Lakes of India and Tibet.

#### SECTION-D

**Geosynclines:** the concept of geosynclines; lithogenetic, orogenetic and tectonic aspects of geosynclines; major types of geosynclines.

Permanence of lands and ocean basins, Continental drift; Snider, Tayler, Weganer, Du Toit; recent views regarding continental drift.

**Mountain building:** Orogeny, orogenic cycles, major orogenic periods of the earth; joly's theory of radioactivity and surface history of the earth, Jaffery's contraction theory Daly's theory of sliding continents, Kobers geosynclinal theory Arthur Holmes convection current theory.

#### Books Recommended

1. Principles of Geomorphology by W.D.Thornibury, John Wiley.
2. Principles of Physical Geology by Arthur Helmes, Nelson 1969.
3. Morphology of the Earth by Lester King.

**NOTE:** *The examiner will set eight questions in all the theory papers selecting two questions from each section. The candidates will answer five questions in all selecting atleast one question from each section.*

## SECTION - A

Stratification, stratified rocks: conformable strata, exposures and outcrops of Sedimentary rocks, horizontal beds, vertical beds, simple inclined beds, strike; dip; apparent dip of beds; superposition; thickness of beds; trends of outcrops; simple mathematical relations.

Top and bottom criteria in Sedimentary strata; significance of ripple marks, ridges and depressions, loads dropped on unconsolidated sediments; inorganic objects; animal tracks, foot prints; fossil shells; buried organic shells; surface cracks; relief due to weathering and eroding, cross bedding or current bedding and graded bedding; contemporaneous deformation; features of igneous rocks; pyroclastic materials, tops of lava surfaces, pillow lavas, bombs, volcanic ash, intrusive igneous beds, drag folds.

Rock deformation: earth forces, static and dynamic conditions, mechanical characteristics of the rocks; kinds of deformation, mechanical deformation, stress and strain external and internal stresses, concept and calculation of stress, the three stages of deformation, stress strain diagrams, Hooke's law, factors controlling the behaviour of materials confining pressure, temperature, time (fatigue, creep), solutions; anisotropy and inhomogeneity; mechanics of plastic deformation, intergranular and intergranular movements, recrystallisation; deformation of the outer shell of the earth.

## SECTION-B

**Fold** :Description of folds, attitude of beds in folds, parts of a fold; nomenclature of fold; symmetric, asymmetric, nonplunging, plunging folds, refolding, fold systems, behaviour of the folds with depth;doubly plunging folds;domes and basins; field study and representation of folds direct observation, mapping, drilling, mining, photographs and sketches of folds, geological maps, structures contour maps, block diagrams; analysis of folding analysis of competent and incompetent folding, development of folding, relation of folding to pressure, flexure folding, flow folding, shear folding, folds due to vertical movements.

**Unconformities** : kinds of unconformities, recognition of unconformities in out crop, aerial mapping contrasts in induration,

metamorphism, intensity of folding, etc., relation to plutonic rocks, palaeontological criteria and other additional criteria; distinguishing faults and unconformities in the field.

Strata with varying dips and varying thickness; preparation of structure contours and isopach maps, isochores and isopachs; lithofacies maps.

### SECTION-C

**Joints** their geometrical and genetic classification failure by rupture in the rocks, experimental data on tension, compression, couple and torsion, analysis of fracture sheering, curved sheering planes; relation of rupture to stress and strain, stress and faulting, fault patterns formed due to the different orientation of principle stress axes, modifying factors rock faulting, stress and strain ellipsoids.

**Faults** : General descriptive terminology, classification of faults as geometric and genetic, field study, representation and recognition of faults, discontinuity of structure repetition and omission of strata, characteristic features along fault planes, silicification and mineralisation, difference in the sedimentary facies, physiographic criteria; distinction between fault line scraps, fault scarps, composite fault scarps etc.

**Extrusive igneous rocks** : lava flow pyroclastic beds fissure eruptions, character of central eruptions, volcanoes classification; craters, calderas and related forms, crypto volcanic and related structures.

**Plutons** : textures and internal structure; age relative to the adjacent rocks structure relations to the surrounding rocks, size and shape; concordant bodies sills, loccoliths. lopoliths, phacoliths, etc., discordant intrusions, dykes, volcanic vents, batholiths and stocks, emplacement of large plutons, magmatic stopping injection, granite tectonics; distinction between primary and secondary structures.

### SECTION-D

**Cleavage and schistosity** : descriptive terminology; origin; slaty cleavage or schistosity, fracture cleavage, slip cleavage and bedding cleavage; relation of cleavage and schistosity to major structures.

**Lineation**: recording the attitude of lineation; relation to major structures; origin deformed pebbles and colities, elongated minerals,

intersection of bedding and cleavage, crinkles, slickensides and mineral streaks, boudinage, rodding and mullion structures, incongruous orientation.

**Structural Petrology** : field methods, field and hand specimens procedure, selection and marking of material, field measurements, orientation of hand specimens; laboratory techniques preparation of material for analysis, preparation of petrofabric diagrams, study of fabric, types of fabric, types of orientation, the tectonite and related concepts; symmetry of fabric and symmetry of movements, their correlation; mechanics of mineral orientation, rotated minerals.

\* **Geophysical method in Structural geology**: General outline of the various physical characters of rocks: general principles of the methods used in the interpretation of Structures based on gravitational, magnetic, Sismic and electrical methods.

#### **Books Recommended**

1. Structural Geology by M.P. Billings.
2. Structural and Tectonic Principle by P.C. Badgley.
3. Folding and Fracturing of Rocks by J.G. Ramsya.
4. Structural Analysis of Metamorphic Tectonites by Turner, F.J. and Weiss, L.E.

*Note :The examiner will set eight questions in all the theory papers selecting two questions from each section. The candidates will answer five questions in all selecting atleast one question from each Section.*

#### **Paper-III Crystallography and Mineralogy**

Maximum Marks : 80

Time : 3 Hrs.

#### **SECTION-A**

##### **Crystallography**

Crystal elements crystal symmetry the laws of crystallography the common holohedral, hemihedral and hemimorphic forms in crystallography; zones, stereographic projection; simple mathematical relationships.

Twinning in crystals; the laws of twinning composition plane and twin plane, twin axis, various examples of twin in crystals.

## SECTION-B

The symmetry characters of the following classes; Cubic: normal, pyritohedral, tetrahedral and plagiohedral. Tetragonal: normal, tripyramidal, pyramidal hemimorphic sphenoidal and trapezohedral, Hexagonal: normal triprismatic, pyramidal hemimorphic, trapezohedral rhombohedral, rhombohedral hemimorphic trihemihedral, Orthorhombic: normal, hemimorphic, sphenoidal monoclinic : normal, Triclinic : normal.

## SECTION-C

**The physical properties of crystals :** gliding planes, properties depending upon light, hardness, specific gravity, isomorphism Polymorphism and pseudomorphism in minerals.

**Descriptive mineralogy :** structure of silicates and its bearing on the classification of various rock-forming silicates detailed study of the principal rock forming mineral groups; garnet, Pyroxene, amphibole, mica, feldspar, scapolite, feldspathoid and calcite groups, their physical optical and chemical characters, their occurrence, origin, association and alteration the mineralogy of the metallic ores; iron, manganese copper, lead, zinc, aluminium, tin, gold, silver, chromium, antimony, arsenic, titanium, uranium, molybdenum and mercury.

## SECTION-D

**Optical mineralogy :** the general principles of optics theories of the propagation of light; the optical properties of minerals, the preparation of material for microscopic study; microscopic study of refringence, the refractometer, double refraction the optical classification of crystals into isotropic and anisotropic crystals; the Mical prism and polaroid plate, polarisation of light; interference colours in crystals and the determination of their order; birefringence in uniaxial and biaxial crystal and its determination; Berek's compensator; Pleochrism and dichroism in crystals and their determination; the construction and use of accessories such as QUARTZ WEDGE/ GYPSUM PLATE AND MICA PLATE : the optical indicatrix of Uniaxial and Biaxial crystals; the determination of optic sign optical anomalies in crystals dispersion in crystals; extinction and its types; extinction angle and its determination; the optic axial angle and its determination; elementary principles and use of the universal stage in the optical study of minerals with special reference to the determination of the feldspars and the optic axial angle.



**Books Recommended for Study :**

1. A text book of Mineralogy by Dana E.S. and Ford, W. E.
2. Rutel's Elements of Mineralogy Read, H.H.
3. Elements of Optical Mineralogy by Winchell, A.N.
4. Optical Crystallography by Wahlstrom, E.E.

NOTE : The examiner will set eight questions in all the theory papers selecting two questions from each section. The candidates will answer five questions in all selecting atleast one question from each section.

**Paper-IV PETROLOGY (IGNEOUS AND METAMORPHIC)**

Max. Marks : 80

Time : 3 Hrs.

**SECTION - A**

Introduction, Scope, importance and development of petrology. Classification of rocks.

Geochemical and trace elements, their abundance and classification, Geochemical prospecting, sedimentation, Classification and characters of sedimentary rocks.

**SECTION B**

Igneous Petrology : Magma, its composition, temperature and origin. Reaction principle and reaction series, study of important binary and ternary silicate systems, Effect of water on crystallisation of such systems. Magmatic differentiation and assimilation. Role of water in the crystallisation of basaltic magma. Classification and texture of igneous rocks, petrographic provinces, Variation diagrams.

**SECTION—C**

Metamorphic Petrology processes and kinds of metamorphism. Chemical principles of metamorphism. Textures of metamorphic rocks, metamorphic minerals and idioblastic series, zones of Regional and Thermal metamorphism, Application of phase rule to metamorphic petrology, facies concept. Facies of contact and regional metamorphism Metasomatism, metamorphic differentiation, Retrograde metamorphism.

**SECTION D**

Origin of important Rock Types : Basalts, Ultrabasics, Anorthosites, Lamprophyres Alkaline Rocks, Granites and migmatites, pegmatites, Charnokites and Khondalities.

**Books Recommended for study**

1. Evolution of Igneous rocks by N.L. Bowen.
2. Petrology for students by A. Harker.
3. Metamorphism by A. Harker.
4. Igneous and metamorphic petrology by Turner F.J. and Verhoeven, L.

PAPER-V PRACTICALS (Structural Geology) M.M. 50

Time : 4½ hrs.

1. Map reading and drawing pertaining to conformable series : horizontal, Vertical and inclined beds, patterns of dipping strata, 'V' shape of the outcrops in the valleys, thickness and depths of the strata; mathematical relations based on apparent dips and true dips, geometric calculations methods; determination of thickness of beds by various methods and order of superposition three points problems
2. Study the following types of Geological maps with uniform thickness of beds; (a) simple, symmetrical, asymmetrical, nonplunging, plunging, doubly plunging overturned and isoclinal folds, domes and basins; recognition of inliers, outliers, anticlinal, valleys, dip slopes, escarpments, etc. (b) unconformities, overlaps and off laps section wings concealed beds. (c) faults, outcrops of faults, strike faults dip faults; and oblique faults, repetition and omission of beds, offset beds, determination of downthrow; determination of barren ground in case of inclined shafts in coal seams.
3. Preparation and interpretation of structure contour maps isopach maps, isochore maps, isolith and isograde maps, and determination of overburden ratios.

4. Geometrical reconstruction folds by Busk method and other methods as follows : (a) for constant thickness (i) method of arcs (ii) methods of chords (iii) methods of tangents (b) of arcs (ii) methods of chords (iii) method of tangents (b) for varying thickness (iv) method of reduced normals (v) method of proportional normals (vi) method of ellipses.
5. Trigonometric solutions, orthographic projections and geometric solutions for fault and three point problems.
6. Stereogram solutions of (i) true dip and apparent dip (ii) plunge and rake of intersection of two planes and fold axes of plunging folds (iii) unconformities (iv) fault problems.
7. Study of some important geological maps of India.

**Note :** For all the three practical papers in M.Sc. Part-I and two practicals paper in M. Sc. Part-II, one external examiner and one Internal examiner will be appointed.

Paper-VI      PRACTICAL (CRYSTALLOGRAPHY AND  
MINERALOGY)

Max. Marks : 50

Time : 4½ Hrs.

**Crystallography**

Study of the holohedral and hemihedral forms of cubic, tetragonal, hexagonal orthorhombic crystals, and of the holohedral classes of monoclinic and triclinic crystals; study of a few important twins from the cubic tetragonal, hexagonal, orthorhombic, monoclinic and triclinic systems; crystal drawing of a few twins of important rock forming minerals, stereographic projection of cubic, tetragonal and orthorhombic crystals such as garnet, zircon, anatase and topaz, calculation of axial ratios in tetragonal, hexagonal and orthorhombic crystals, calculation of zone symbol and symbol of imperfect faces occurring between known zones.

**Mineralogy**

A study of the macroscopic and microscopic characters of the more important rock-forming minerals; determination of refringence by immersion method using the Becke offset; determination of the order of interference colours of minerals; determination of pleochroic scheme of biaxial minerals; study

of the conoscopic figures of uniaxial and biaxial crystals using the optic axial and acute bisectri figures; determination of extinction angle using sensitive tint plate and by the bio-frennel law; determination of the optic axial angle on the universal stage; determination of the composition of feldspars by the Reinhard method.

**Note :** For all the three practical Papers in M.Sc. Part I and two practicals paper in M.Sc. Part-II, Exam. one external examiner and one Internal examiner will be appointed.

**Paper-VII                      Petrology Practical**

Maximum Marks : 50

Time : 4½ hours.

1. (i) Study of the textures of igneous rocks in hand specimens and in thin sections.  
(ii) Study of important igneous rocks in hand specimens and in thin sections.  
(iii) Study of textures and structures of metamorphic rocks in hand specimens and in thin sections.  
(iv) Study of important metamorphic rock types in hand specimens and in thin sections.
2. Study of typical rock assemblages in hand specimens and in thin sections and their petrogenetic interpretation.
3. Model Analysis.
4. Interpretation of chemical analysis of rocks.

**Note :** For all the three practical papers in M.Sc. Part-I and two practicals Paper in M.Sc. Part-II, one external examiner and one Internal examiner will be appointed.

**M.Sc. PART-I (GEOLOGY)**

**Paper-VIII**

**Dissertation**

Max. Marks : 30

During the course of the year, each student shall be required to go for Surface Geological mapping to the suitable Geological area conducted by the teachers of the Department. It will be a field work of three weeks duration and one teacher will guide atleast four students.