M.Sc. Geology

Ordinance and Syllabus

As per

National Education Policy -2020

ACADEMIC SESSION

(2022-2023)

Department of Earth & Planetary Sciences

Prof. Rajendra Singh (Rajju Bhaiya) Institute of Physical Sciences for Study and Research

V.B.S. PURVANCHAL UNIVERSITY, JAUNPUR

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Department of Earth & Planetary Sciences,

Prof. Rajendra Singh (Rajju Bhaiya) Institute of Physical Sciences for Study and Research,
V.B.S. Purvanchal University, Jaunpur

Ordinance governing two-year (four semesters) postgraduate degree (M.Sc.)

The following ordinances have been framed governing the admission, course structure, examination and other allied matters relating to the two-year (four semesters) postgraduate degree programme (M.Sc.) in Geology being offered by **Prof. Rajendra Singh (Rajju Bhaiya) Institute of Physical Sciences for Study and Research,** V.B.S. Purvanchal University. The University adopted the semester and credits-based courses w.e.f. session 2022-23.

A. ADMISSION

1. All matters relating to admission to this course shall be dealt with by the Admission Committee constituted for the purpose by the University.
2. All candidates, who have passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or equivalent bachelor courses from a recognized university/institutions are eligible for admission. Preference will be given to candidates who have studied Geology at B.Sc. level
3. The intake of students in these programmes shall be fixed by V.B.S. Purvanchal University. The reservation norms for admission shall be guided by State Government notification issued from time to time.
4. On selection the candidates shall deposit the fees prescribed for the purpose to get his/her admission confirmed within the time period fixed by the Admission Committee of the Department. If a candidate fails to do so his/her admission shall be automatically cancelled and the seat falling vacant shall be offered to other candidates as per the merit/category. However, matter concerning fees of candidates under SC/ST category would be governed by Govt. Order; as such there is no provision of fee concession/exemption/refund.
5. Admission to M.Sc. course cannot be claimed by any candidate as a matter of right. The Admission Committee shall have power to refuse, reject or cancel any admission if it possesses sufficient reasons to do so.

B. COURSES OF STUDY AND EXAMINATION

6. To conduct the M.Sc. (Geology) programme systematically and within a time bound frame, the concerned Department shall draw up an "Academic Calendar" in the beginning of academic session and shall get it approved by the Vice-Chancellor of the University for its Strict Implementation.
7. A candidate admitted to the M.Sc. course shall pursue a regular course of study in all the four semesters of the course and attend at least 75% of the classes held to be eligible to appear in the examination.
8. If a student fails to attend requisite classes in a semester due to illness, he/she may be given relaxation of 15% attendance (10% at the level of Vice-Chancellor and 5% at the level of Head of Department on production of medical certificate).
9. The examination for semester system in M.Sc. Course in Geology shall be by means of theory papers and practical as specified in the examination scheme which consist of:

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(a) Four theory papers and one practical examinations in each of the Seventh, Eighth, Ninth and tenth semesters.

(b) It is also necessary to do a project work in each semester under the guidance of a faculty member of the department.

10. All papers (Theory and Practical) will be of 4 credits (25% Internal + 75% External) except stated otherwise. Project will of 4 credits and maximum 100 marks. Duration for examination of a paper will be of 3 hours.

11. Students are required to take a minor elective (other than own department/faculty) and pass it in seventh or eighth semester (first year of M.Sc.) for the completion of M.Sc. Geology Programme.

12. The Departmental Committee/Department shall assign a topic for Project Work/ dissertation/survey along with a supervisor to a candidate in the beginning of each semester.

13. An evaluation of project work will be carried by a board of examiners consisting of an external examiner and an internal examiner (supervisor). The Board of Examiners will consist of one External and one/two internal examiners(supervisor) recommended for appointment by the BoS/HoD of department.

14. The name of the candidates successful in the semester system in M.Sc. Course in Geology examination shall be arranged in the following grade system:

लैटर ग्रेड	विवरण	अंको की सीमा	ग्रेड पॉइंट
O	Outstanding	91-100	10
A+	Excellent	81-90	9
A	Very good	71-80	8
B+	Good	61-70	7
B	Above Average	51-60	6
C	Average	41-50	5
P	Pass	36-40	4
F	Fail	0-35	0
AB	Absent	Absent	0
Q	Qualified		
NQ	Not Qualified		

15. Matters pertaining to the syllabi and conduct of examination shall be dealt with by the Board of Studies (BOS) constituted by the Vice-Chancellor.

16. The BOS shall recommend the panel of paper setters/examiners to the Vice-Chancellor. After getting approval from the Vice-Chancellor, the appointment letters shall be issued to the concerned paper setters/examiners by the Registrar/Controller of Examination of Purvanchal University.

17. Papers for theory examination in sealed covers shall be handed over/sent by registered post to the Registrar/Controller of Examination by the Examiners. Controller of Examinations/Technical Cell will ensure the printing of papers and fair conduct of the examinations.

18. The question papers shall be moderated by a committee consisting of the head and two senior most teachers of the department and the teacher of concerned paper.

19. After the examinations, Controller of Examinations/Technical Cell for campus courses shall ensure the evaluation of the answer books and declaration of results of semester examinations within a reasonable time so as to enable the department to adhere to the Academic Calendar.

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20. Practical examinations of semester VII, VIII, IX and X shall be conducted by at least one internal and one external examiner carrying 100 marks in each semester.

21. The students of M.Sc. course shall be examined in the subjects in accordance with course curriculum given at the end of ordinance.

C. RESULTS, PROMOTION AND IMPROVEMENT

22. The pass marks in each semester shall be (i) 36% marks in each theory papers subject to 36% marks in the total of theory. (ii) 36% marks in practical examinations (iii) 40% marks in project works.

23. If a student fails in more than 5 papers in an academic year, he/she will not be promoted to next year. Such student should be re-admitted as Ex. Student with coming batch and their seat will be additional.

24. Students, who failed in 5 or lower number of papers in the academic year will be awarded 'back' and given unlimited chances to reappear and pass in respective paper(s) in next 3 years with regular semester examination.

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Department of Earth and Planetary Sciences

About the Program: M.Sc. Geology

Geology is a branch of natural science concerned with Earth and other astronomical objects, the features or rocks of which it is composed, and the processes by which they change over time. The subject has contributed immensely to the improvement of the life of humans by providing many of human requirements and essentialities. A trained Geologist uses a wide variety of methods including field work, rock description, geophysical techniques, chemical analysis, physical experiments, and numerical modelling to understand the Earth's structure and evolution, for exploration and exploitation of minerals and hydrocarbon, water resources, understanding natural hazards, remediation of environmental problems, and providing insights into past climate change. Beside this, geology is a major academic discipline, and it is central to geological engineering and plays an important role in geotechnical engineering. The developments in Geology during last few decades are phenomenal. The aid of computers and instrumental technologies has not only accelerated growth in the practice, but revolutionized the entire field. A geologist cannot isolate himself from other disciplines of science and engineering, therefore a symbiotic interdisciplinary approach now seems to be more relevant and more specialization in graduate and post-graduate syllabi is need of time.

Program Outcome

The M.Sc. program in Department of Earth and Planetary Sciences, V.B.S. Purvanchal University, Jaunpur is developed with the objective that the students acquire strong theoretical and practical knowledge in various domains of Geology and achieve success as a geo-scientist in academia, industry, or research. The program offer students the knowledge and skill base that would enable them to undertake advanced studies in geology and related areas or in multidisciplinary areas that involve geology. The theoretical papers on geomorphology, petrology, remote sensing & G.I.S., geophysics, engineering geology, geohydrology as well as geochemistry will impart in-depth knowledge about the earth system whereas the practical courses will prepare the students with laboratory skills in geology. The project works are designed to make students able to conduct experiments, analyse and interpret scientific data in a useful form. The program will prepare them for a successful career having employability in government sector, public sector, private sector, research institutes, or further qualifying NET or GATE examinations so as to pursue research for doctoral studies. The students are likely to get regular placements in Geological Survey of India, Oil and Natural Gas Commission, Coal India Limited, etc. apart from reputed private organizations related to oil industries, mineral exploration & mining industries and organisations working in the fields of exploration. In addition, the holistic development of students helps them in getting placements in various national institutes like Birbal Sahni Institute of Palaeosciences, Wadia Institute of Himalayan Geology, Physical Research Laboratory, National Geophysical Research Institute, National Institute of Oceanography etc. Moreover, students will learn values for lifelong learning to meet the ever-evolving professional demands by developing ethical, interpersonal, and team skills.

Programme Specific Outcome

During the proposed four semesters, students will identify, examine and understand different geological materials, geological settings and associations. The students with their robust foundation learn to interpret various geological maps, prepare cross sections, geologic field mapping, understanding of stratigraphic concepts, geological successions of Precambrian to Recent rocks, sediments and their lateral and vertical disposition; rock identification on the basis of minerals composition and basic physical, megascopic and microscopic characters. They learn about the origin and evolution of landforms, fossil identification up to generic level, their evolution and mode of life, in-depth understanding of the sedimentary structures and facies analysis, various rock types based on petrological thin sections, paleoclimatic and paleogeographic changes, origin and distribution of economic mineral and energy resources of the country etc. The students also develop basic aptitude and understanding of the environmental issues related to planet earth. At the end of the program

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student will be able to amalgamate the spatial and temporal relationships between earth processes and products, and development and evolution of earth spheres (Lithosphere, Hydrosphere, Atmosphere and Biosphere). Exploration for economically useful Earth material is another important outcome of the present program. Geological excursion and research-based dissertation would be important components of the Master's Program in Geology for laying a robust foundation to the budding geologists. During the dissertation, students will take-up a geological problem utilize theoretical knowledge along with analytical or experimental approach to solve it. Students will get exposure of actual rocks during Geological excursion. Students will learn the data collection, measurements and interpretations.

The Full Structure and Scheme of the Semester Courses for the M.Sc. GEOLOGY with detailed Syllabus

Subject Code	Title	Teaching Hours per week			Maximum Marks			Credits
		L	T	P	Sessional Marks	End-semester Examination	Total Marks	
SEMESTER I								
B0907011T	Introduction to Earth & Planetary Sciences	3	1	0	25	75	100	4
B0907021T	Sedimentology	3	1	0	25	75	100	4
B0907031T	Mineralogy & Crystallography	3	1	0	25	75	100	4
B0907041T	Igneous & Metamorphic Petrology	3	1	0	25	75	100	4
B0907051P	Practical	0	0	12	25	75	100	4
B0907061R	Project*	0	0		-	-	100	4
	Minor#						100	4
Total							**700**	**28**
SEMESTER II								
B0908011T	Structural Geology	3	1	0	25	75	100	4
B0908021T	Stratigraphy	3	1	0	25	75	100	4
B0908031T	Geomorphology	3	1	0	25	75	100	4
B0908041T	Elective@	3	1	0	25	75	100	4
B0908051P	Practical	0	0	12	25	75	100	4
B0908061R	Project**	0	0		-	-	100	4
Total							**600**	**24**
Elective								
B0908041T-A	Remote Sensing & GIS	3	1	0	25	75	100	4
B0908041T-B	Environmental Geology & Natural Hazards	3	1	0	25	75	100	4
SEMESTER III								
B0909011T	Palaeontology	3	1	0	25	75	100	4
B0909021T	Engineering Geology	3	1	0	25	75	100	4
B0909031T	Economic & Mining Geology	3	1	0	25	75	100	4
B0909041T	Elective@	3	1	0	25	75	100	4
B0909051P	Practical	0	0	12	25	75	100	4
B0909061R	Project***	0	0		-	-	100	4
Total							**600**	**24**
Elective								
B0909041T-A	Coal & Petroleum Geology	3	1	0	25	75	100	4
B0909041T-B	Field Geology & Instrumentation Techniques	3	1	0	25	75	100	4
SEMESTER IV								
B0910011T	Geochemistry	3	1	0	25	75	100	4
B0910021T	Exploration Geophysics	3	1	0	25	75	100	4
B0910031T	Geohydrology	3	1	0	25	75	100	4
B0910041T	Elective@	3	1	0	25	75	100	4
B0910051P	Practical	0	0	12	25	75	100	4
B0910061R	Project****	0	0		-	-	100	4
Total							**600**	**24**
Elective								
B0910041T-A	Soil Geology	3	1	0	25	75	100	4
B0910041T-B	Climatology & Oceanography	3	1	0	25	75	100	4
B0910041T-C	Gemology	3	1	0	25	75	100	4

L – Lecture; T - Tutorial; P – Practical; *Students will have to make a project (Model/Chart) under the guidance of the supervisor and give its demonstration in class; #Students are required to choose a minor course offered by the other departments in the other faculty; @Students have to choose one out of two or three elective courses offered by the department. Any one course to be run depending more than 50% of the students choose that course; **Students will have to complete a Term Paper under the guidance of the supervisor for detail study of the recent developments in the subject based on research

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papers published on assigned topic and submit a report that will be followed by a Viva-Voce. ***Students will have to complete a Dissertation in the respective specialization under the guidance of the supervisor and submit a report followed by a presentation. ****Students will have to go to a field work in some appropriate area of geological importance and submit a report on its completion.

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M.Sc. GEOLOGY SEMESTER I

Programme/Class: **M.Sc.**	Year: **Fourth**	Semester: **Seventh**
Subject: **Geology**		
Course Code: **B090701T**	Course Title: **Introduction to Earth & Planetary Sciences**	

Course outcomes: After completing the course, student

- Will learn origin of solar system and Earth
- Will understand internal structure of Earth
- Will understand interpretation stress-strain imprinted in earth
- Will understand structure and composition of the atmosphere
- Will understand fundamental forces in the atmosphere
- Will understand atmospheric pollution and its various sources

Credits: 4	**Core Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: **40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **3-1-0**

Unit	Topics	No. of Lectures
I	Origin of Solar system; Characteristic of planets in detail; Kepler's Laws of Planetary Motion; Bode's Law, Evolution of the Earth; Earth's internal structure.	15
II	Principles of geodesy, Isostasy, Plate tectonics, Continental drift, Geomagnetism, Sea-floor spreading, Earthquakes and Volcanoes; Rock cycle.	15
III	Structure and composition of the atmosphere; atmospheric boundary layers and study of atmosphere on the basis of lapse rate: Prevailing and adiabatic lapse rates, Isothermal constant lapse rate, dry adiabatic lapse rate, Homogeneous lapse rate; Humidity: definition derivation of relative and absolute humidity; Potential temperature dew point temperature, Instability of dry and moist air; Geopotential; Condensation nuclei; Precipitation.	15
IV	Fundamental forces in the atmosphere; Coriolis force and the Geostrophic wind, Gradient wind, Pressure Gradient wind, Basic structure and mechanism of atmospheric general circulation; Cyclones, Anticyclones and jet stream. Atmospheric Pollution and its various sources. Atmospheric aerosols and its affects with special emphasis on the processes occurring in the Indo-Gangetic basin.	15

Suggested Readings:

1. Gass I.G., Smith, J. Peter, and Wilson R. C. L. (1982): Understanding the Earth. Artemis Press (Pvt.) Ltd. U.K.
2. Holmes, A. (1992): Holmes Principles of Physical Geology Edited by P. McL. D. Duff. Chapman and Hall, London.
3. Byers, H.R. (1974): General Meteorology. McGraw Hill.
4. William Lowrie,1997: Fundamentals of Geophysics, Cambridge University Press.
5. Holton, J. R. and Hakim, G. J. (2013): An introduction to Dynamic Meteorology. Academic Press.
6. Alan Trujilo & Harold V. Thurman Essentials of Oceanography, 12th Edition, Pearson.
7. Brown, G. C. and Mussett, A. E. (1993): The Inaccessible Earth: An integrated view to its structure and composition. Springer Dordrecht.
8. Condie, K.C. (2015): Earth as an Evolving Planetary System. Elsevier.
9. Wallace, J.M. and Hobbs, P.V. (2006): Atmospheric Science: An Introductory Survey (2nd Edition). Academic Press.

This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**

Suggested Continuous Evaluation Methods:
Total Marks: 25
Sessional test: 15 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 5 Marks
Class performance/Participation: 5 Marks

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Course prerequisites: To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.
Suggested equivalent online courses:
Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fourth**	Semester: **Seventh**
Subject: **Geology**		
Course Code: **B090702T**	Course Title: **Sedimentology**	

Course outcomes: After completing the course, student

- will be able to understand the processes of the formation of sedimentary rocks.
- will understand fundamentals of sedimentary processes and their products.
- will have a complete understanding about the texture, structures of clastic sedimentary rocks
- will gain understanding of fundamentals of fluid flow and fluid-sediment interaction.
- will understand composition and significance of different types of clastic sedimentary rocks.
- will understand tectonic formation and evolution of sedimentary basins.
- will understand sedimentary facies and environments.

Credits: **4**	**Core Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: **40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **3-1-0**

Unit	Topics	No. of Lectures
I	Sedimentary rock: definition and its scope; Classification of sedimentary rocks: Conglomerates, Sandstones, Shales, and Carbonate rocks. Provenance of Clastic sediments, Biogenic and Volcanogenic sediments, Diagenesis of Siliciclastic and Carbonate rocks. Some known Indian Sedimentologists and their contributions.	15
II	Sedimentary textures- Grain size, Roundness, Sphericity, Shape and Fabric; Quantitative grain size analysis, Elements of hydraulics, Flow regimes and processes of sediment transport, Different type of sedimentary structures-their genesis and Stratigraphic significance, Penecontemporaneous deformation structure; Biogenic structures; Principles and application of Paleocurrent analysis.	15
III	Composition and significance of different types of Sandstone, Limestone, Banded iron formation, Mudstone, Conglomerate; Carbonate Diagenesis and Dolomitization. Tectonics and sedimentation. Formation and evolution of sedimentary basins: Geo-synclinal and plate tectonic models, Basin analysis.	15
IV	Sedimentary facies and environments, Facies modelling for marine, non-marine and mixed sediments. Carbonate platforms- types and facies models; Reconstruction of Paleoenvironments. Principles of sequence Stratigraphy- concepts and factors controlling, base level changes, Bed, Bedset, Parasequence, Parasequence boundary, Parasequence set; Clinoform, Systems tract, Unconformity and Sequence boundary.	15

Suggested Readings:

1. Sengupta, S.M. (2007): Introduction to sedimentology. C.B.S. Publication, New Delhi.
2. Prothero D.R. and Schwab, F. (2004): Sedimentary Geology. Freeman.
3. Mc Lane, M. (1995): Sedimentology. Oxford University press, U.S.A.
4. Blatt, H., Middleton, G.V. and Murray, R.C. (1980): Origin of Sedimentary Rocks. Prentice Hall Inc, New Jersey.
5. Collinson, J.D., and Thompson, D.B., (1982): Sedimentary Structures. George Allen and Unwin, London.
6. Lindholmn, R.C., (1987): A Practical Approach to Sedimentology. Allen and Unwin, London.
7. Miall, A.D. (2000): Principles of Sedimentary Basin Analysis. Springer-Verlag.
8. Petti john, F. J. (1975): Sedimentary Rocks (3rd Edition). Harper and Row Publisher.
9. Reading, H.G. (1997): Sedimentary Environments and facies. Blackwell Scientific Publication.
10. Reineck, H.E. and Singh, I.B. (1973): Depositional Sedimentary Environments. Springer-Verlag.
11. Selley, R.C. (2000): Applied Sedimentology. Academic Press.

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12. Tucker, M.E. (1981): Sedimentary Petrology: An Introduction. Wiley and Sons, New York.
13. Tucker, M.E. (1990): Carbonate Sedimentology. Blackwell Scientific Publication.

This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**

Suggested Continuous Evaluation Methods:
Total Marks: 25
Sessional test: 15 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 5 Marks
Class performance/Participation: 5 Marks

Course prerequisites:
To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.

Suggested equivalent online courses:

Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fourth**	Semester: **Seventh**
Subject: **Geology**		
Course Code: **B090703T**	Course Title: **Mineralogy and Crystallography**	

Course outcomes: After completing the course, student
- Will learn the minerals and it types.
- Will know the physical and optical properties of mineral
- Will learn formation of mineral groups and resource
- Will understand the crystal formation, forms, and occurrences

Credits: **4**	**Core Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: **40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **3-1-0**

Unit	Topics	No. of Lectures
I	Mineral: definition, physical properties of minerals; Silicate Structures, Structure and Classification of rock-forming minerals- Olivine, Garnet, Aluminosilicates, Pyroxene, Amphibole, Mica, Feldspar, Clay, Silica and Spinel group.	15
II	Polarizing Microscope and accessory plates, Optical properties of minerals- Uniaxial and Biaxial crystals, Indicatrix, Double refraction, Pleochroism, Sign of elongation, Interference figures and optic sign.	15
III	Twinning and Twin Laws: common types of Twins and their examples in minerals, Polymorphism, Pseudomorphism, Isomorphism, Solid solution and exsolution.	15
IV	Symmetry, Miller indices; Zoning, Concept of unit cell and Bravais lattices; 32 Crystal classes, Types of bonding, Pauling's rules and Co-ordination number.	15

Suggested Readings:

1. Dana, E. S. and Ford, W. E. (2002): A Textbook of Mineralogy. Wiley Eastern Limited, New Delhi.
2. Deer, W. A., Howie, R. A. and Zussman, J. (2013): An Introduction to the Rock-Forming Minerals (3rd Edition). The Mineralogical Society, London.
3. Berry, L.G., Mason, B. and Dietrich, R.V. (1985): Mineralogy: Concepts, Descriptions and determinations. C.B.S. publishers.
4. Phillips, F.C (1971): Introduction to Crystallography. Longman Group Publication.
5. Kerr, P. F. (1997): Optical Mineralogy. McGraw Hill Book Company.
6. Klein, C. and Hurlbut, C. S., Jr. (1977): Manual of Mineralogy. (21st Revised Edition), John Wiley Sons, Inc., New York.
7. Winchell, E. N. (1951): Elements of Optical Mineralogy. John Willey and Sons Inc.
8. Borchardt-Ott, Walter (2011): Crystallography an Introduction (3rd Edition). Springer-Verlag Berlin Heidelberg.
9. Nesse, William D. (2012): Introduction to mineralogy (2nd Edition). Oxford University Press.
10. Nesse, William D. (2012): Introduction to optical mineralogy (3rd Edition). Oxford University Press.

This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**
Suggested Continuous Evaluation Methods: Total Marks: 25 Sessional test: 15 Marks Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 5 Marks Class performance/Participation: 5 Marks
Course prerequisites: To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.
Suggested equivalent online courses:
Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fourth**	Semester: **Seventh**
Subject: **Geology**		
Course Code: **B090704T**	Course Title: **Igneous and Metamorphic Petrology**	

Course outcomes: After completing the course, student

- Will have basic understanding of formation, form and occurrence of common igneous rocks.
- Will understand the classification schemes of the igneous rocks
- Will learn the fundamentals of thermodynamics and its application to igneous petrology.
- Will learn primary and secondary textures
- Will learn about the formation of the metamorphic rocks and related ore minerals
- Will learn the different kind of metamorphic processes on the earth
- Will learn the geothermobarometry and its applications

Credits: **4**	**Core Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: **40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **3-1-0**

Unit	Topics	No. of Lectures
I	Igneous Petrology: Definition of important rock types, Structural and tectonic control and mode of emplacement of different igneous rocks, Classification of igneous rocks. Elements of Thermodynamics, Enthalpy, Entropy, Gibb's free energy, Phase equilibria studies on different rock types at variable temperature and pressure, different systems of binary, ternary diagram, Solid solution series.	15
II	Detail studies on rocks of Basalt family, Granites family, Kimberlites, Peridotites, Komatiites, Ophiolites, Feldspathoid-bearing volcanic rocks, Lamprophyres and Anorthosites. Some known Indian petrologists and their contributions.	15
III	Metamorphic Petrology: Types, Structure and textures of Metamorphic rocks, Concepts of metamorphic facies, Different facies and sub-facies assemblages in a P-T grid, Graphic representation of typical facies assemblages.	15
IV	Thermobarometery and metamorphic P-T-t paths and their tectonic significance, Contact, Burial and Regional metamorphism, (Green Schist facies and Almandine-Amphibolite facies), Granulite facies, Migmatization and Shock Metamorphism. UHP and UHT metamorphism.	15

Suggested Readings:

1. Bose, M.K. (1997): Igneous Petrology, World Press, Kolkata.
2. Best, Myron G. (2002): Igneous and Metamorphic Petrology, Blackwell Science, C.B.S. publishers, Delhi.
3. Cox, K.G., Bell, J.D. and Pankhurst, R.J. (1993): The Interpretation of Igneous Rocks. Champman and Hall, London.
4. Faure, G. (2001): Origin of Igneous Rocks. Springer.
5. Le Maitre R.W. (2002): Igneous Rocks: A Classification and Glossary of Terms, Cambridge, University Press.
6. McBimey (1994): Igneous Petrology. C.B.S. publishers Delhi.
7. Phillpotts, A.R. (1994): Principles of Igneous and Metamorphic Petrology. Prentice Hall of India.

8. Sood, M.K. (1982): Modern Igneous Petrology. Wiley-Interscience Publ., New York.
9. Wilson, M. (1993): Igneous Petrogenesis. Chapman and Hall, London.
10. Winter, J.D. (2001): An Introduction to Igneous and Metamorphic Petrology. Prentice Hall, New Jersey.
11. Bucher K. and Martin F. (2002): Petrogenesis of Metamorphic Rocks (7th Rev. Ed.). Springer–Verlag.
12. Yardley B.W.D., Mackenzie W.S. and Guilford C. (1995): Atlas of Metamorphic Rocks and their textures. Longman Scientific and Technical, England.
13. Yardlley B.W.D. (1989): An Introduction to Metamorphic Petrology. Longman Scientific and Technical, New York.

This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**

Suggested Continuous Evaluation Methods:
Total Marks: 25
Sessional test: 15 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 5 Marks
Class performance/Participation: 5 Marks

Course prerequisites:
To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.

Suggested equivalent online courses:

Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fourth**	Semester: **Seventh**
Subject: **Geology**		
Course Code: **B090705P**	Course Title: **Practical- Crystallography, Mineralogy and Petrology**	

Course outcomes: After completing the course, student
- Will able to identify and characterize the minerals and igneous, sedimentary and metamorphic rocks in hand specimen.
- Will able to identify and characterize the minerals and igneous, sedimentary and metamorphic rocks in thin sections.

Credits: **4**	**Core Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: **40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **0-0-12**

Unit	Topics	No. of Lectures
	Crystallography & Mineralogy: Identification of rock-forming minerals in hand specimens. Study of the optical properties of minerals in thin sections. ***Petrology:*** Study of igneous, sedimentary and metamorphic rocks in hand specimen and in thin sections.	60

Suggested Readings:

1. Dana, E. S. and Ford, W. E. (2002): A Textbook of Mineralogy. Wiley Eastern Limited, New Delhi.
2. Deer, W. A., Howie, R. A. and Zussman, J. (2013): An Introduction to the Rock-Forming Minerals (3rd Edition). The Mineralogical Society, London.
3. Kerr, P. F. (1997): Optical Mineralogy. McGraw Hill Book Company.
4. Klein, C. and Hurlbut, C. S., Jr. (1977): Manual of Mineralogy. (21st Revised Edition), John Wiley Sons, Inc., New York.
5. Nesse, William D. (2012): Introduction to mineralogy (2nd Edition). Oxford University Press.
6. Nesse, William D. (2012): Introduction to optical mineralogy (3rd Edition). Oxford University Press
7. Cox, K.G., Bell, J.D. and Pankhurst, R.J. (1993): The Interpretation of Igneous Rocks. Champman and Hall, London.
8. LeMaitre R.W. (2002): Igneous Rocks: A Classification and Glossary of Terms, Cambridge University Press.
9. Winter, J.D. (2001): An Introduction to Igneous and Metamorphic Petrology. Prentice Hall, New Jersey.

This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**

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Suggested Continuous Evaluation Methods: Practical Record: 20 Marks, Class participation and activity: 5, Examination: 50 Marks, Viva-voce: 25 marks
Course prerequisites: To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.
Suggested equivalent online courses:
Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fourth**	Semester: **Seventh**
Subject: **Geology**		
Course Code: **B090706R**	Course Title: **Project**	
Course outcomes: After completing the course, student • Identify the potential research problem • Prepare synopsis of a defined research problem. • Perform the bench work. • Interpret the acquired data. • Prepare the research project report. • Get exposure of vigorous laboratory training which will help students to boost their research carrier.		
Credits: **4**	Core Compulsory	
Max. Marks: **100**	Min. Passing Marks: **40**	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-6		
Every student shall be required to undertake Research Project Work and submit a detailed report to the Department Head, with the signature of guide faculty member. The marks awarded for the work shall be on the basis of the submitted research project report, seminar and viva voce.		

M.Sc. GEOLOGY SEMESTER II

Programme/Class: **M.Sc.**	Year: **Fourth**	Semester: **Eighth**
Subject: **Geology**		
Course Code: **B090801T**	Course Title: **Structural Geology**	

Course outcomes: After completing the course, student

- Will understand interpretation of stress-strain imprinted in earth.
- Will understand definition and classification of folds, faults and other deformation processes, primary and secondary structures.
- Will understand orogenic processes and salient structural features within India and the World.
- Will understand Fundamental concept of Geo-tectonics and motion of the plate.

Credits: **4**	**Core Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: **40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **3-1-0**

Unit	Topics	No. of Lectures
I	Definition, Primary and Secondary structures, Methods and application of structural geology. Stress and Strain, Fold elements and terminology, Classification: Geometrical, Morphological and Genetic, Origin and Development of folds, Superposed Folds. Determination of top and bottom of beds. Recognition and Representation of folds.	15
II	Classification, and origin of joints, relation to other structures. Faults, terminology and Classification, Structures associated with faults. Gravity, Thrust and Strike-slip faults classification and description. Mechanics of fracturing. Block, Rifted and Wrench-faulted regions, Thrusts and Nappe structures, Tectonic mélanges, Dome and Basin structures, Metamorphic terrains, Mylonite zone and Pseudotachylytes.	15
III	Different types of unconformities, Meteoritic Impact structures and Impactites, Collapse compaction, Diapers, Salt domes. Orogenic Belts of India and the World. Salient structural features of the Himalayan Arc, Indo-Gangetic Plain, Peninsular India and Indian Ocean.	15
IV	Fundamental concept of Geo-tectonics, its theoretical and practical importance. Orogenic and Epeiorogenic Phases; Concept and theories of Isostasy; Origin and significance of Mid-Oceanic Ridges and Trenches; Island arcs and Mountain chains, Their global distribution and evolution. Concept of Sea floor spreading; Evidence of continental drift. Concept of Plate Tectonics, Nature and types of Plate Margins, Geometry and Mechanism of Plate Motion. Tectonic and Economic significance of Plate Tectonics.	15

Suggested Readings:

1. Davis G.H., Reynolds S.J. and Kluth C.F. (2011): Structural Geology of Rocks and Regions (3rd edition). John Wiley and Sons, Inc.
2. Hatcher R.D. (1995): Structural Geology, principles, Concepts and Problems. Prentice Hall.
3. Ghosh S.K. (1993): Structural Geology, Fundamentals and Modern Developments. Pergamon Press.
4. Ghosh S.K and Sengupta S. (1997): Evolution of geological structures in Micro- to Macroscales.
5. Springer, Berlin.
6. Ramsay J.G. and Huber M.I. (2003): The Techniques of Modern Structural Geology (Volume 1) Strain Analyses. Academic Press.
7. Ramsay J.G. and Huber M.I. (2003): The Techniques of Modern Structural Geology (Volume 2) Folds and Fracture. Academic Press.
8. Marshak S. and Mitra G. (1988): Basic Methods of Structural Geology. Prentice Hall.
9. Richard J. Lisle (2003): Geological Structures and Maps: A Practical Guide. Butterworth-heinemann.
10. Park R. G. (2004): Foundation of Structural Geology. Routledge.
11. Fossen H. (2010): Structural Geology. Cambridge University Press.
12. Pollard D. D. and Fletcher R. C. (2005): Fundamentals of Structural Geology. Cambridge University Press, New York.
13. Ragan D. M. (2009): Structural Geology: An Introduction to Geometrical Techniques. Cambridge University Press.
14. Windley B. (1973): The Evolving continents. John Wiley and Sons, New York.
15. Condie K.C. (1982): Plate Tectonics and Crystal Evolution. Pergamon Press Inc., New York.

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This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**
Suggested Continuous Evaluation Methods: Total Marks: 25 Sessional test: 15 Marks Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 5 Marks Class performance/Participation: 5 Marks
Course prerequisites: To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.
Suggested equivalent online courses:
Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fourth**	Semester: **Eighth**
Subject: **Geology**		
Course Code: **B090802T**	Course Title: **Stratigraphy**	

Course outcomes: After completing the course, student

- Will able to understand basic principles and concept of stratigraphy.
- Will able to understand physiographic divisions, Structure and tectonic history of Indian subcontinent.
- Will know about stratigraphic sequences of different parts of the Indian subcontinents.
- Will understand origin of different cratons, mobile belts, and basins of Indian subcontinents and their correlation with other parts of the globe.
- Will understand depositional environments and tectonostratigraphic framework of India spanning Archaean to Holocene, and mass extinction boundaries.
- Will gain understanding of paleogeography, paleoclimatic and tectonic set up of India in the past.
- Will understand evolution of the Himalaya.

Credits: **4**	**Core Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: **40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **3-1-0**

Unit	Topics	No. of Lectures
I	Basic principles and definitions; Stratigraphic classification and Nomenclature; Brief account on Magnetostratigraphy, Stable Isotope Stratigraphy, Tephrochronology and Event Stratigraphy; Stratigraphic correlation, Palaeontological and non-Palaeontological criteria of correlation; Graphic correlation; Facies concept in stratigraphy; Lateral migration of facies. Introduction to Sequence stratigraphy, Eustatic Sea level changes through geologic time, Conformity and sequence unconformities, sequence architecture, Flooding surface, maximum flooding surface, marine flooding surface; System tracts- lowstand system tract, Transgressive system tract, highstand system tract, Overlap, off lap, Top lap and On lap, Aggradation, Progradation, Retrogradation, Transgression and Regression. Contributions of some Indian scientists in stratigraphy.	15
II	Physiographic divisions, Structure and tectonic history of Indian subcontinent; Precambrian basement of Indian Peninsula. Archaean rocks: distribution, classification and economic importance; Precambrian basement of Extra-peninsula- Tethyan basement, Lesser Himalaya; Basement-cover transition; Proterozoic formations of Indian Peninsula- Cuddapah, Delhi, Bijawar and Gwalior Group and their equivalents. Vindhyan Supergroup and its equivalents; Correlation of equivalent Proterozoic formations in Extra-peninsular India. Chronology of Orogenies.	15
III	Paleozoic Era- Paleogeographic, Paleoclimatic and tectonic set up, A detailed study of succession, lithology, Age, Depositional environments, Economic importance and fossil contents of various formations of Salt Range, Tethys Himalaya and Lesser Himalaya Ranges; Gondwana sequences. Mesozoic Era- Paleogeographic, Paleoclimatic and tectonic set up formations of Extra-peninsular and Peninsular India. Deccan Traps: distribution, Petrology and age. Lameta beds, Bagh beds, Inter-trappeans and Infra-trappeans.	15

IV	Cenozoic Era- Paleogeographic, Paleoclimatic and tectonic set up along with Himalayan Orogeny. A detailed study of succession, Lithology, Age, Depositional environments, Economic importance and fossil contents of various Paleogene and Neogene formations of Extra-peninsular and Peninsular India; Siwalik Supergroup.	15

Suggested Readings:

1. Krishnan, M.S. (1982): Geology of India and Burma, C.B.S. Publ, Delhi, John Wiley and Sons, New York.
2. Nichols, G. (1999): Sedimentology and stratigraphy, Blackwell Science, Oxford, 355 pages, ISBN 0-632-03578-1.
3. Ramakrishnan, M. and Vaidyanadhan, R. (2008): Geology of India (In 2 Volumes), Geological Society of India, Bangalore.
4. Kumar, R. (1996): Fundamentals of Historical geology and stratigraphy of India. New Age International Publishers.
5. Schoch, R.M. (1989): Stratigraphy: principles and methods, Van Nostrand Reinhold.
6. Coe, Angela L., Bosence, D.W.J., Church Kevin D., Flint, Steve, Howell, John, Wilson, R. and Chris L. (2002): The Sedimentary Record of Sea Level Change, Cambridge University Press.
7. Emery, D. and Myers, K.J. (1996): Sequence Stratigraphy. Blackwell Scientific.
8. Miall, A.D. (1997): The Geology of Stratigraphic Sequence. Springer-Verlag.
9. Reineck, H.E. and Singh, I.B. (1980): Depositional Sedimentary Environments. Springer-Verlag.
10. Valdiya, K.S. (2016): The Making of India: Geodynamic Evolution. Springer Cham.
11. Jain, A.K., Banerjee,D.M., and Kale S., Vivek (2020): Tectonics of the Indian Subcontinent. Springer Cham.
12. Sharma, Ram (2010): Cratons and Fold Belts of India. Springer Berlin, Heidelberg.

This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**

Suggested Continuous Evaluation Methods:
Total Marks: 25
Sessional test: 15 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 5 Marks
Class performance/Participation: 5 Marks

Course prerequisites:
To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.

Suggested equivalent online courses:

Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fourth**	Semester: **Eighth**
Subject: **Geology**		
Course Code: **B090803T**	Course Title: **Geomorphology**	

Course outcomes: After completing the course, student
- Will understand basic concepts and significance of geomorphology.
- Will understand Erosion and evolution of landforms.
- Will understand applications of geomorphology in other sciences.
- Will understand geomorphology of India.

Credits: **4**	**Core Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: **40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **3-1-0**

Unit	Topics	No. of Lectures
I	Basic concepts and significance of Geomorphology, Concept of erosion cycles. Rock weathering and soils. Mass wasting. Influence of climate on processes.	15
II	Geomorphology of Fluvial tracts, Arid zones, coastal regions, Karst landscapes and Glaciated ranges.	15

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III	Morphometric analysis of river basin, applications of geomorphology in mineral prospecting, Civil engineering, Hydrology and Environmental studies.	15
IV	Topographical maps. Geomorphology of India: Peninsular, extra-peninsular and Indo-Gangetic Plains.	15

Suggested Readings:

1. Thornbury, W.D. (2004): Principles of Geomorphology (2nd edition). C.B.S. Publication.
2. Kale, V.S. and Gupta, Avijit (2010): Introduction to geomorphology. University Press.
3. Holmes, A. (1992): Holmes Principles of Physical Geology Edited by P. McL. D. Duff. Chapman and Hall, London.
4. Halis, J.R. (1983): Applied Geomorphology.
5. Sharma, H.S. (1990): Indian Geomorphology. Concept Publishing Co. New Delhi.
6. Small, R.J. (1978): Study of Landforms: A Textbook of geomorphology (2nd Edition). Cambridge
7. University Press.
8. Bloom, A.L. (2011): Geomorphology: A systematic analysis of Late Cenozoic Landforms (3rd
9. Edition). Rawat Publications.
10. Singh, Savindra (2016): Geomorphology. Pravalika Publication Allahabad.
11. Siddhardha, K. (2016): The Earth's Dynamic Surface- A book of Geomorphology. Kitab Mahal.
12. Summerfield, M.A (2011): Geomorphology and Global Tectonics. Wiley India Pvt Ltd.
13. Gautam, A. (2015): Geomorphology (5th Edition). Sharda Pustak Bhavan Allahabad.

This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**

Suggested Continuous Evaluation Methods:
Total Marks: 25
Sessional test: 15 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 5 Marks
Class performance/Participation: 5 Marks

Course prerequisites:
To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.

Suggested equivalent online courses:

Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fourth**	Semester: **Eighth**
Subject: **Geology**		
Course Code: **B090804T-A**	Course Title: **Remote Sensing & GIS**	

Course outcomes: After completing the course, student

- Will learn the state of art technology, being effectively used to monitor and assess the earth's resources.
- Will able to develop skills of interpretation of the visual and digital satellite data.
- Will understand the interaction of humans with the geological environment.
- Will learn to prepare various thematic maps useful in mineral exploration, flood monitoring, land use landcover mapping, earth resource management etc.

Credits: **4**	Elective
Max. Marks: **25+75**	Min. Passing Marks: **40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **3-1-0**

Unit	Topics	No. of Lectures
I	Basics of Remote Sensing, Electromagnetic spectrum; Electromagnetic bands in remote sensing; Scattering, Reflection, Atmospheric Window; Spectra of common natural objects– soil, rock, water and vegetation. Aerial photos – types, scale, resolution; properties of aerial photos. Stereoscopy, Parallax, Relief displacement, Elements of photo and imagery pattern and interpretation.	15
II	Data Processing and Interpretation (Digital Image Processing – DIP), Characteristics of remote sensing data, Pixel, Digital number; Pre-processing; Enhancements, Classification. Elements of Photo and Imagery pattern and Interpretation– drainage,	15

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	erosion, details, Grey tones.	
III	General orbital characteristics of remote sensing satellites, GPS. General sensor characteristics of remote sensing satellites: LANDSAT, IRS, SPOT. Geographic information systems (GIS): Principles and components of GIS, Remote sensing data integration with GIS.	15
IV	Application of satellite meteorology: Identification of cloud types and patterns in satellite images, synoptic systems, estimation of SST, cloud top temperatures, winds and rainfall. Remote sensing and GIS applications in various geological aspects such as in structural geology, mineral exploration, assessing groundwater potentials, environmental monitoring.	15

Suggested Readings:

1. Drury, S.A. (1987): Image Interpretation in Geology. Allen and Unwin.
2. Lillesand, T.M. and Kiefer, R.W. (1987): Remote Sensing and Image Interpretation. John Wiley, New York.
3. Siegal, B.S. and Gillespie, A.R. (1980): Remote Sensing in Geology. John Wiley.
4. Gupta, R.P. (1991): Remote Sensing Geology. Springer, Berlin.
5. Sabins, F.F. (2007): Remote Sensing: Principles and Interpretation. Waveland Pr. Inc., New York.

This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**

Suggested Continuous Evaluation Methods:
Total Marks: 25
Sessional test: 15 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 5 Marks
Class performance/Participation: 5 Marks

Course prerequisites:
To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.

Suggested equivalent online courses:

Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fourth**	Semester: **Eighth**
Subject: **Geology**		
Course Code: **B090804T-B**	Course Title: **Environmental Geology and Natural Hazards**	

Course outcomes: After completing the course, student

- Will understand concepts and principles of environmental geology.
- Will be able to understand the interaction of humans with the geological environment.
- Will understand natural hazards and acquire basic knowledge related to its occurrence, causes, impact and mitigation.
- Will learn disaster management and understand climate variabilities, anthropogenic hazards and its risk management.

Credits: **4**	Elective
Max. Marks: **25+75**	Min. Passing Marks: **40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **3-1-0**

Unit	Topics	No. of Lectures
I	Time scales of global changes in the ecosystems and climate. Causes and impact of climate change on the society. Milankovitch cycle, Sea level rise. Eutrophication and Acid rain. Concepts and principles of environmental geology, Environmental hazards-prevention and precautions.	15
II	Earthquakes: seismic waves, Ray-path geometry in layered ground, loss of seismic energy, seismic energy sources, detection and recording of seismic waves, applied seismology. Distribution, magnitude and intensity of earthquakes, Precaution and prevention measures of following hazards: Floods: their causes and control. Landslides: Landslide hazards: causes and investigations; Coastal erosion: causes and related	15

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	engineering structures.	
III	Green House gases and effect, Global warming, Pollution in the atmosphere. Water: Impact assessment of degradation and contamination of surface water and groundwater quality due to industrialization and urbanization. Soil: Soil profiles and soil quality degradation due to irrigation, use of fertilizers and pesticides. Population increase: Urbanization and land use changes and related hazards. Geological investigations of nuclear waste disposal sites.	15
IV	Disaster management: Evaluating hazards, past history, linkages between hazardous events, precursor events, prediction, probability of occurrence, risk determination, acceptable risk, problems and opportunities in risk assessment, human response to hazard and disaster, artificial control of natural processes.	15

Suggested Readings:

1. Valdiya, K.S. (1987): Environmental Geology–Indian Context. Tata McGraw Hill.
2. Keller, E.A. (1978): Environmental Geology. Bell and Howell, U.S.A.
3. Bryant, E. (1985): Natural Hazards. Cambridge University Press.
4. Patwardhan, A.M. (1999) The Dynamic Earth System. Prentice Hall, ISBN: 81203149649788120314962.
5. Subramaniam, V. (2001): Textbook in Environmental Science. Narosa International.
6. Bell, F.G. (1999): Geological Hazards. Routledge, London.
7. Reynolds J. M. (1998) An introduction to Applied and Environmental Geophysics, John Wiley & sons, England, ISBN: 0-471-96802, pp. 796.
8. Canter, L.W. (1977): Environmental impact assessment. MC Graw Hill, New York.

This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**

Suggested Continuous Evaluation Methods:
Total Marks: 25
Sessional test: 15 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 5 Marks
Class performance/Participation: 5 Marks

Course prerequisites:
To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.

Suggested equivalent online courses:

Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fourth**	Semester: **Eighth**
Subject: **Geology**		
Course Code: **B090805P**	Course Title: **Practical- Stratigraphy, Structural Geology, Remote sensing & GIS**	

Course outcomes: After completing the course, student

- Will able to use basic instruments/techniques used in fields.
- Will learn to determine dip, strike, directions and interpret the geological maps and related structures in field.
- Will know about important igneous and metamorphic rock suites of India by plotting them on the map.
- Will able to do visual interpretation of lithology and learn application of G.I.S.

Credits: **4**	**Core Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: **40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **3-1-0**

Unit	Topics	No. of Lectures
	Structural Geology: Introduction to Clinometer, Brunton and GPS. Determination of true dip from apparent dip measured in different directions, determination of angle of pitch, plunge, etc. Interpretation of geological structures from maps, solution of various structural geological problems by graphical and stereographic projection.	60

	Stratigraphy: Plotting of important stratigraphic locations on the map of India. Plotting of important igneous and metamorphic rock suites on the map of India. ***Remote sensing & GIS:*** Determination of scale in aerial photos. Measurement of heights of objects from aerial photos. Study and interpretation of single and stereopair aerial photos. Basic application of ArcGIS SOFTWARE.	

Suggested Readings:

1. Bennison, G. M. (1992): An introduction to geological structures and maps. Springer US.
2. Lisle, Richard J. (2020): Geological structures, and maps: A practical guide (4th Edition). Butterworth-Heinemann
3. Krishnan, M.S. (1982): Geology of India and Burma, C.B.S. Publ, Delhi, John Wiley and Sons, New York
4. Ramakrishnan, M. and Vaidyanadhan, R. (2008): Geology of India (In 2 Volumes), Geological Society of India, Bangalore.
5. Valdiya, K.S. (2016): The Making of India: Geodynamic Evolution. Springer Cham.
6. Drury, S.A. (1987): Image Interpretation in Geology. Allen and Unwin.
7. Gupta, R.P. (1991): Remote Sensing Geology. Springer, Berlin.
8. Lillesand, T.M. and Kiefer, R.W. (1987): Remote Sensing and Image Interpretation. John Wiley, New York.

This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**

Suggested Continuous Evaluation Methods: Practical Record: 20 Marks, Class participation and activity: 5, Examination:50 Marks, Viva-voce: 25 marks

Course prerequisites: To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.

Suggested equivalent online courses:

Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Eighth**
Subject: **Geology**		
Course Code: **B090806R**	Course Title: **Project**	

Course outcomes: After completing the course, student

- Identify the potential research problem
- Prepare synopsis of a defined research problem.
- Perform the bench work.
- Interpret the acquired data.
- Prepare the research project report.
- Get exposure of vigorous laboratory training which will help students to boost their research carrier.

Credits: **4**	**Core Compulsory**
Max. Marks: **100**	Min. Passing Marks: **40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-6

Every student shall be required to undertake Research Project Work and submit a detailed report to the Department Head, with the signature of guide faculty member. The marks awarded for the work shall be on the basis of the submitted research project report, seminar and viva voce.

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M.Sc. GEOLOGY SEMESTER III

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Ninth**
Subject: **Geology**		
Course Code: **B090901T**	Course Title: **Palaeontology**	

Course outcomes: After completing the course, student

- Will know the evolutionary processes and distribution of life of vertebrate and invertebrate fossils, micro-fossils, plant fossils, and trace fossils on the earth.
- Will understand the geological time scale in the view of species and correlation.
- Will understand the characteristics of different species on earth during the geological past.
- Will know the causes of extinction of species during geological past.
- Will acquire skills of describing fossils and their taxonomic classification.
- Will learn the application of palaeontology and the use of fossils in hydrocarbon exploration, establishing biostratigraphy, inferring palaeoecology, palaeobiogeography of the geological past.

Credits: **4**	Core Compulsory
Max. Marks: **25+75**	Min. Passing Marks: **40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **3-1-0**

Unit	Topics	No. of Lectures
I	Definition, objectives and scope. Conditions and modes of fossilization. Organic evolution and classification. Concept of species. Habit and habitats. Dispersal, migration and extinction. Paleoecology, concepts and approaches. Taphonomy.	15
II	Detailed shell morphology, classification, composition and structure of the shell and geological description of the following invertebrate fossil groups; Brachiopoda, Bivalvia, Gastropoda and Cephalopoda.	15
III	Morphology, classification and geological description of Echinoidea, Trilobita, Graptoloidea and Corals. Evolutionary trends in Graptoloidea and Ammonoidea. Functional morphology of bivalvia. Buoyancy of cephalopod shells. Heteromorphs and extinction in ammonites. Elements of micropaleontology and its applications. Collection and preparation of microfossils. Types of microfossils. Brief morphological study of the following types of microfossils and their paleoceanographic and paleoenvironmental significance; Calcareous (Foraminifera, Ostracoda, Pteropods), Siliceous (Radiolaria, Diatoms).	15
IV	Brief morphological study of Phosphatic (Conodonts) and Organic- walled (Acritarchs, Tasmanitids and Dinoflagellates) microfossils. Introduction to paleobotany with special reference to Gondwana plant fossils. Introduction to vertebrate paleontology. Vertebrate life through geological time. Study of Siwalik vertebrate fauna. Brief study about evolution of dinosaur, horse, elephant and primate.	15

Suggested Readings:

1. Clarkson, E.N.K. (1998): Invertebrate Palaeontology and Evolution. ELBS/Allen and Unwin, London.
2. Prothero, D.R. (1998): Bringing Fossil to Life–An Introduction to Palaeontology. McGraw Hill.
3. Raup, D.M. and Stanley, S.M. (1985) Principles of Palaeontology. W.H. Freeman and Company, New York.
4. Colbert, E.H. (1984): Evolution of Vertebrates. Wiley Eastern Ltd.
5. Benton, M.J. (1990): Vertebrate Paleontology. Unwin Hyman, Lindon.
6. Haq, B.U. and Boersma, A. (1998): Introduction to Marine Micropaleontology. Elsevier.
7. Arnold (2002): Quaternary Environmental Micropaleontology (Editor Simon K. Haslett), Oxford University Press.
8. Bignot, G. (1985): Elements of Micropaleontology. Springer Science & Business Media.
9. Jones, T.P. and Rowe, T.P. (1999): Fossil plants and spores, Modern Techniques. Geological Society of London.
10. Saraswati, P.K. and Srinivasan, M.S. (2016): Micropaleontology: Principles and Applications. Springer.

This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**

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Suggested Continuous Evaluation Methods: Total Marks: 25 Sessional test: 15 Marks Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 5 Marks Class performance/Participation: 5 Marks
Course prerequisites: To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.
Suggested equivalent online courses:
Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Ninth**
Subject: **Geology**		
Course Code: **B090902T**	Course Title: **Engineering Geology**	

Course outcomes: After completing the course, student

- Will know the importance of earth sciences in engineering.
- Will understand mechanical properties of rocks and soils.
- Will now the types of earth movements, causes and remedial measures
- Will understand the landslides and their remedial measures.
- Will understand about construction materials used for roads and mechanical behavior of foundation rocks and soils.
- Will understand potential geological hazards and suggested remedial measures for construction of tunnels, underground power plants and hydraulic structures like dam.

Credits: **4**	Core Compulsory
Max. Marks: **25+75**	Min. Passing Marks: **40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **3-1-0**

Unit	Topics	No. of Lectures
I	Engineering geology- Importance of earth sciences in engineering. Mechanical Properties of Rocks and Soils: Elastic, An-elastic and Plastic behaviour of material, Stress and Strain state in rocks, Longitudinal strain, Shear strain, young's modulus, Rigidity modulus, Bulk modulus, Compressibility, Poisson's ratio.	15
II	Earth Movements, types, causes and remedial measures, Landslides in clayey rocks, sliding movement in hard rocks, Stabilization of slopes in slide areas and other preventive measures, Construction Materials, Geological criteria for selection of construction material for various uses, viz. Concrete aggregate rip-rap, Rigid and Flexible Pavements, Facing, Roofing and Raving, Environmental impact on materials.	15
III	Foundation of Building, Industrial Structures and Bridges: Mechanical behaviour of foundation rocks and soils. Geological investigation of the building or bridge sites. Tunnels and Underground Power Plants: Types of tunnels, Tunnelling methods, Geological investigations along tunnel alignments. Potential geological hazards and suggested remedial measures.	15
IV	Hydraulic Structures: Types of Dams. Basic considerations of forces on dams, Geological and geomorphological criteria for selection of dam sites. Dam sites on igneous, Metamorphic and Siltation of reservoirs.	15

Suggested Readings:

1. Krynine, D.H. and Judd, W.R. (1998): Principles of Engineering Geology., C.B.S. Publishers.
2. Schultz, J.R. and Cleaves, A.B. (1951): Geology in Engineering. John Willey and Sons, New York.
3. Singh, Prabin (2013): Engineering and General Geology. S.K. Kataria and Sons.

This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**

Suggested Continuous Evaluation Methods:
Total Marks: 25
Sessional test: 15 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 5 Marks
Class performance/Participation: 5 Marks

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Course prerequisites: To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.
Suggested equivalent online courses:
Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Ninth**
Subject: **Geology**		
Course Code: **B090903T**	Course Title: **Economic and Mining Geology**	

Course outcomes: After completing the course, student

- Will able to understand the formation of the different types of economic minerals and deposits
- Will learn classifying the economic minerals
- Will understand the genetic controls exerted by physical and chemical processes on ore formation in various geologic settings.
- Will understand different types of economic minerals of India and their reserves.
- Will understand the mining processes.
- Will understand Mineral policy of India and economic and policy issues related to minerals and their national importance.

Credits: **4**	Core Compulsory
Max. Marks: **25+75**	Min. Passing Marks: **40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **3-1-0**

Unit	Topics	No. of Lectures
I	Mode of occurrence, origin, classification of economic deposits (magmatic, metamorphic, contact metasomatic, sublimation, hydrothermal, oxidation and supergene enrichment and sedimentary), Porphyry and skarn mineralization. Fluid inclusion studies.	15
II	Mineralization associated with (i) Ultramafic, mafic and Acidic rocks, (ii) Greenstone belts, (iii) Komatiites, Anorthosites and Kimberlites and (iv) Submarine volcanism, Stratiform and Strata bound ores. Ores and metamorphism cause and effect relations, Forms of ore deposits.	15
III	Methods of ore microscopy. Metallogenic epochs and provinces of India, Strategic, essential and Critical minerals with examples. Origin and distribution of important metallic (some base metals, iron, manganese, aluminium, chromium, nickel, gold, silver, molybdenum) and Non-metallic mineral deposits (asbestos, barytes, gypsum, graphite, apatite and beryl), Phosphorite deposits, Rare earth mineral deposits, Raw material for ceramic, refractory, cement, paint, fertilizer, and glass industries and building stones, Gemstones. Distribution of mineral deposits in India.	15
IV	Introduction: Classification of mining methods. Mining Methods: Placer mining methods, open pit methods, Underground mining methods, Coal Mining methods and Ocean bottom mining methods; their advantages and disadvantages. Ventilation in underground mining: Purpose, types and arrangements of ventilation in underground mining. Mining hazards and safety measures. India's status in mineral production; co-products and by-products, consumption, substitution and conservation of minerals; National Mineral Policy, Mineral Concession Rules, Marine mineral resources and Laws of the sea.	15

Suggested Readings:

1. McKinstry, H. E. (1976): Mining Geology. Prentice Hall, Englewood Clifts, N.J.
2. McKinstry, H.E. (1948): Mining Geology. Prentice Hall, Englewood Clifts, N.J.
3. Clark, G.B. (1967): Elements of Mining (3rd edition). John Wiley.
4. Arogyaswami, R.P.N. (1996): Courses in Mining Geology (4th Edition). Oxford & I.B.H. Publishing.
5. Gaudin, A.M. Principles of Mineral Dressing. McGraw Hill Publishing Company Limited, Bombay.
6. Prasad, U. (2003): Economic geology. C.B.S. Publishers, Delhi.
7. Bateman, A.M. (1959): Economic mineral deposits. Asia Publishing House.
8. Evans, A.M. (1993): Ore geology and Industrial minerals, Blackwell.
9. Mookherjee, A. (2000): Ore genesis-A holistic approach. Allied Publishers, New Delhi.

10. Stanton, R.L. (1972): Ore Petrology. McGraw Hill, New York.1.
This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**
Suggested Continuous Evaluation Methods: Total Marks: 25 Sessional test: 15 Marks Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 5 Marks Class performance/Participation: 5 Marks
Course prerequisites: To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.
Suggested equivalent online courses:
Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Ninth**
Subject: **Geology**		
Course Code: **B090904T-A**	Course Title: **Coal and Petroleum Geology**	

Course outcomes: After completing the course, student

- Will learn the process of formation of coal.
- Will understand the classification and characterization of coal.
- Will understand distribution of coal in India.
- Will learn about the generation of coalbed methane and its reservoir.
- Will understand the process of formation of petroleum and its characterization.
- Will understand the types of reservoirs for the petroleum.
- Will earn about the petroliferous basins of India.

Credits: **4**	Elective
Max. Marks: **25+75**	Min. Passing Marks: **40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **3-1-0**

Unit	Topics	No. of Lectures
I	Definition and origin of coal. Sedimentology of coal bearing strata, types of seam discontinuities and structures associated with coal seams. Chemical analysis of coal (proximate and ultimate analysis). Coal Petrology – concept of 'Lithotype', 'Maceral' and 'Micro-lithotype'. Classification and optical properties of macerals and micro-lithotypes. Application of coal petrology.	15
II	Classification of coal in terms of Rank, Grade and types. Elementary Idea about coal preparation, Coal carbonization, Coal gasification, Coal hydrogenation, coal Combustion and fertilizer form coal. Coalbed methane – a new energy resource. Elementary idea about generation of methane in coalbeds, coal as a reservoir and coalbed methane exploration. Coal as a source rock in petroleum generation. Geological and geographical distribution of coal and lignite deposits in India. Indian coal reserves and production of coal in India. Coal exploration and estimation of coal reserves.	15
III	Petroleum – its composition. Origin (Formation of source rocks-kerogen, organic maturation and thermal cracking of kerogen) and migration of petroleum. Reservoir rocks-porosity and permeability. Reservoir traps – structural, Stratigraphic and combination traps. Oilfield fluids –water, oil and gas. Oil shale.	15
IV	Methods of prospecting for oil and gas (geological modelling). Elementary knowledge of drilling and logging procedures. An outline of oil belts of the world. Onshore and offshore petroliferous basins of India. Geology of productive oilfields of India.	15

Suggested Readings:

1. Chandra, D., Singh, R.M. Singh, M.P., (2000): Textbook of Coal (Indian context). Tara Book Agency, Varanasi.
2. Singh, M.P. (Ed.) (1998): Coal and organic Petrology. Hindustan Publishing Corporation, New Delhi.
3. Scott, A.C. (1987): Coal and Coal-bearing strata: Recent Advances. The geological Society of London, Blackwell scientific Publications.
4. Stach, E., Mackowsky, M-Th., Taylor, G.H., Chandra, D., Teichumullelr, M. and Teichmuller R.

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(1982): Stach Texbook of Coal petrology. Gebruder Borntraeger, Stuttgart.
5. Stach, E., Mackowsky, M-Th., Taylor, G. H., Chandra, D., Teichumullelr, M. and Teichmuller, Holson, G. D. and Tiratso, E. N. (1985): Introduction to Petroleum Geology. Gulf Publishing, Houston, Texas.
6. Tissot, B.P. and Welte, D.H. (1984): Petroleum Formation and Occurrence. Springer – Verlalg.
7. North, F.K. (1985): Petroleum Geology. Allen Unwin.
8. Suárez-Ruiz, Isabel John Crelling (2008): Applied Coal Petrology: The Role of Petrology in Coal Utilization. Academic Press.
9. Taylor, G.H., Teichmuller, M., Davis, A., Diessel, C.F.K., Littke, R. and Robert P., (1998): Organic Petrology, Gebruder Borntraeger, Stuttgart.
10. Holson, G.D. and Tiratso, E.N. (1985): Introduction to Petroleum Geology. Gulf Publishing, Houston, Texas.
11. Selley, R.C. (1998): Elements of Petroleum Geology. Academic press.

This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**

Suggested Continuous Evaluation Methods:
Total Marks: 25
Sessional test: 15 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 5 Marks
Class performance/Participation: 5 Marks

Course prerequisites:
To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.

Suggested equivalent online courses:

Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Ninth**
Subject: **Geology**		
Course Code: **B090904T-B**	Course Title: **Field Geology & Instrumentation Techniques**	

Course outcomes: After completing the course, student
- Will learn Field Geology and Mapping Techniques.
- Will learn procedures to collect samples and specimens.
- Will understand role and importance of some common instrumentation techniques in geosciences, their principle and application.
- Will able to handle and process the geological data collected in the field and laboratory using various statistical tools.
- Will be trained to use computers and different processing software in geology.

Credits: **4**	Elective
Max. Marks: **25+75**	Min. Passing Marks: **40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **3-1-0**

Unit	Topics	No. of Lectures
I	Introduction to Field Geology and Mapping Techniques, Essential Equipment and Supplies, Compass, Clinometer and GPS, Topographic Maps, Aerial Photographs and Satellite images, Mapping Methodology and basic field procedures, Recording Observations, Geological Mapping.	15
II	Procedures to collect samples and specimens, Identification and description of various minerals, rock types, primary and secondary structures and fossils and biogenic structures, Stratigraphy of the area based on field observations. Preparation and submission of a Field Report.	15
III	Various sample preparation techniques in mineralogy; Historical development of Xray crystallography and Bragg's equation. Introduction to Instrumental Techniques involved in mineral characterization (Powder X-Ray diffraction Analysis, Electron Microprobe Analysis, FTIR and Laser Raman Spectroscopy). Introduction to mineral formulae calculation of important rock forming minerals.	15

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IV	Various sample preparation techniques in geochemical analyses; Historical development of Mass Spectrometers, principle, application and their utility in geosciences.	15

Suggested Readings:

1. Mathur S.M. (2001): Guide to Field Geology. Prentice-Hall of India Pvt. Ltd., New Delhi, 220p. ISBN: 81-203-1915-X.
2. Bhattacharyya A. and Chakraborty C. (2005): Analysis of Sedimentary Successions: A Field Manual. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi-Kolkata. 445p.
3. McClay K.R. (2005): The Mapping of Geological Structures. John Wiley & Sons, Chichester, 161p.
4. Compton R.R. (1962): Manual of Field Geology. John Wiley & Sons Inc., 378 p.
5. Barnes J.W. and Lisle R.J. (2004): Basic Geological Mapping (Geological Field Guide). John Wiley & Sons Inc., 378p. ISBN: 978-0-470-84986-6.
6. Dhanaraju, R. (2009) Handbook of geochemistry: techniques and applications in mineral exploration. Geological Society of India.
7. Perkins, D. (2013): Mineralogy. Prentice Hall.
4. Ramachandra Rao, M.B. (1975): Outlines of geophysical prospecting: a manual for geologists. Ms. Wesley Press, Mysore.
5. Ramana Murty, V.V. (2012): Operational Hand book of mineral Processing. Denett & Co.
6. Reed, S.J. B. (1996): Electron Microprobe Analysis and Scanning electron Microscopy in Geology. Cambridge University press.

This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**

Suggested Continuous Evaluation Methods:
Total Marks: 25
Sessional test: 15 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 5 Marks
Class performance/Participation: 5 Marks

Course prerequisites:
To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.

Suggested equivalent online courses:

Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Ninth**
Subject: **Geology**		
Course Code: **B090905P**	Course Title: **Practical- Palaeontology, Economic and Mining Geology**	

Course outcomes: After completing the course, student

- Will see and feel the natural fossils.
- Will identify and characterize the fossils.
- Will know the palaeo-life of earth.
- Will be able to know the age of the rock formations based on fossils.
- Will know the reconstruction of the earth based on fossils.
- Will identify the ore minerals and associated processes.

Credits: 4	Core Compulsory
Max. Marks: **25+75**	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-12

Unit	Topics	No. of Lectures
	Palaeontology: Study of specimens illustrating morphological characters of some important invertebrate fossils. Study of morphological characters of some important Gondwana plant fossils. ***Economic and Mining Geology:*** Study of economic minerals in hand specimen and under microscope. Preparation of mineral map of India.	60

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Suggested Readings: 1. Clarkson, E.N.K. (1998): Invertebrate Palaeontology and Evolution. ELBS/Allen and Unwin, London. 2. Jones, T.P. and Rowe, T.P. (1999): Fossil plants and spores. Modern Techniques. Geological Society of London. Prothero, D.R. (1998): Bringing Fossil to Life–An Introduction to Palaeontology. McGraw Hill. 3. Raup, D.M. and Stanley, S.M. (1985) Principles of Palaeontology. W.H. Freeman and Company, New York. 4. Arogyaswami, R.P.N. (1996): Courses in Mining Geology (4th Edition). Oxford & I.B.H. Publishing. 5. Evans, A.M. (1993): Ore geology and Industrial minerals, Blackwell. 6. Prasad, U. (2003): Economic geology. C.B.S. Publishers, Delhi. 7. Krishnan, M.S. (1982): Geology of India and Burma. C.B.S. Publ, Delhi, John Wiley and Sons, New York. 8. Ramakrishnan, M. and Vaidyanadhan, R. (2008): Geology of India (In 2 Volumes), Geological Society of India, Bangalore. 9. Kumar, R. (1996): Fundamentals of Historical geology and stratigraphy of India. New Age International Publishers.
This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**
Suggested Continuous Evaluation Methods: Practical Record: 20 Marks, Class participation and activity: 5, Examination:50 Marks, Viva-voce: 25 marks
Course prerequisites: To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.
Suggested equivalent online courses:
Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Ninth**
Subject: **Geology**		
Course Code: **B090906R**	Course Title: **Project**	
Course outcomes: After completing the course, student observe and interpret the outcrops, exposures, landscapes, structures, dip, strike, and related rock types		
Credits: 4	Core Compulsory	
Max. Marks: **100**	Min. Passing Marks: 40	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-6		
Every student shall be required to attend the field training and submit a detailed field work report, properly labelled and arranged collected specimens, and field diary with the signature of field tour guide faculty members to Head of the Department. The marks awarded for the field work shall be on the basis of these records, collection and performance in the field		

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M.Sc. GEOLOGY SEMESTER IV

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Tenth**
Subject: **Geology**		
Course Code: **B091001T**	Course Title: **Geochemistry**	

Course outcomes: After completing the course, student

- Will be able to understand the evolution of the early Earth from protoplanetary material and its differentiation to present day state.
- Will be able to understand the evolution of the early atmosphere.
- Will understand geochemical classification of elements and their cycling.
- Will learn about the stable isotopes and their application in geology.
- Will learn about the radiogenic isotopes and the basic techniques and processes of dating earth materials and various geological events.
- Will understand limitations and implications of geochemistry and isotopes in petrogenesis of sedimentary and igneous rocks.

Credits: **4**	Core Compulsory
Max. Marks: **25+75**	Min. Passing Marks: **40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **3-1-0**

Unit	Topics	No. of Lectures
I	Introduction of Geochemistry and Cosmochemistry. Chemical composition and properties of Earth's layers. Atmosphere: its layers, chemical composition and evolution of Atmosphere. Meteorites, classification, mineralogy, origin, significance and phenomena of fall.	15
II	Geochemical cycle; Minor cycle and Major cycle. Geochemical classification of elements. Periodic table with special reference to rare earth elements and transition elements.	15
III	Stable isotope geochemistry of Carbon, Hydrogen, Oxygen and Nitrogen and its application in Geology. Cosmogenic radionuclides.	15
IV	Radiogenic isotopes. Decay scheme and methods of dating by K-Ar, Ar-Ar, Sm-Nd, Re-Os, Lu-Hf, U-Pb and Rb-Sr. Sr and Nd isotope geology in meteorites, igneous rocks, sedimentary rocks, fission track dating.	15

Suggested Readings:

1. Rankama, K. and Sahama, Th. G. (1950) Geochemistry. Univ. Chicago Press.
2. Mason, B. and Moore, C.B. (1991) Introduction to Geochemistry, Wiley Eastern.
3. Krauskopf, K.B. (1967): Introduction to Geochemistry. McGraw Hill, 616 pages, ISBN 0-07-035447-2.
4. Fyfe, W. S. (1964): Geochemistry of Solids. McGraw Hill, New York, ISBN 10: 0070226458
5. Bloss, F. D. (1971): Crystallography and Crystal Chemistry. Holt, Rinehart, and Winston, New York.
6. Klein, C. and Hurlbut, C. S. (1993): Manual of Mineralogy, John Wiley & Sons, New York, 682 pages, ISBN 0-471-31266-5.
7. Das H. A., A. Faanhof and H. A. Van Der Sloot, Radioanalysis in Geochemistry, Elsevier Publishers.
8. Gunter Faure (1977) Principles of Isotope Geology. John Wiley & Sons Ltd.
9. Alan P. Dickins (2005) Radiogenic Isotope Geology. Cambridge University Press.
10. Hoefs, J. (1980): Stable Isotope Geochemistry. Springer and Verlag.
11. Hugh R. Rollinson (2007) Early Earth Systems: A Geochemical Approach. Blackwell Publishing Ltd.
12. Hugh R. Rollinson (1993) Using Geochemical Data: Evaluation, Presentation and Interpretation. Pearson Prentice Hall.
13. Albarde Francis (2003): Geochemistry- Introduction. Cambridge University Press.
14. Kula C Misra (2012): Introduction to Geochemistry: Principles and Applications. Wiley-Blackwell.

This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**

Suggested Continuous Evaluation Methods:

Total Marks: 25

Sessional test: 15 Marks

Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 5 Marks

Class performance/Participation: 5 Marks
Course prerequisites: To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.
Suggested equivalent online courses:
Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Tenth**
Subject: **Geology**		
Course Code: **B091002T**	Course Title: **Exploration Geophysics**	

Course outcomes: After completing the course, student

- will understand the physical properties of interior of the planet 'Earth'.
- will understand basic principles of geophysical investigation for understanding background and anomaly in different physical properties.
- Will know about various geophysical techniques and their application to explore the mineral, water, and hydrocarbon reserves.

Credits: **4**	Core Compulsory
Max. Marks: **25+75**	Min. Passing Marks: **40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **3-1-0**

Unit	Topics	No. of Lectures
I	Basic principles of geophysical exploration. Gravity Method: Gravity force and potential. Stable and unstable gravimeters, field procedure and reduction of gravity data. Various types of corrections applied to gravity data, preparation of gravity anomaly maps. Gravity effect of spherical body.	15
II	Magnetic Method: Basic Theory, inverse square law, concept of potential, magnetism on atomic scale, Dia- para- ferro magnetic materials, susceptibilities and densities of various rocks and minerals, magnetic properties of rocks. Basics of Magnetometer.	15
III	Electrical methods: Electrical resistively, current distribution in homogeneous ground due to single electrode and dipoles. Resistively method: Basic principles, various types of electrode configurations, Wenner, and Schlumberger configurations. Elements of SP and IP method.	15
IV	Seismic Method: Elementary principle of reflection and refraction methods. Ray parameter. Geometry for seismic wave paths: Reflection from single-horizontal interface, normal-move-out. Different methods for velocity estimation. Dipping reflector, Dip-move-out. Geometry of Seismic refraction paths. Head waves, single-horizontal refractor, method of estimation of velocity of layers and depth of the interface. Estimation of velocity and thickness of layers. Intercept time, delay time. Geophones, Electromagnetic geophones. Hydrophones.	15

Suggested Readings:

1. Telford, W.M., Geldart, L.P., Sheriff, R.E. and Keys, D. A., (1990): Applied Geophysics, Cambridge University Press.
2. Dobrin, Milton B. and Savit, Carl H. (1988); Introduction to Geophysical Prospecting (4th Edition). McGraw-Hill Education.
3. Lowrie, William (2007): Fundamentals of Geophysics (2nd Edition). Cambridge University Press.
4. Robinson, Edwin S. (1988); Basic Exploration Geophysics. John Wiley and Sons.
5. Gadallah, M.R., Fisher, R. and Fisher, R.L. (2008); Exploration Geophysics. Springer.

This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**

Suggested Continuous Evaluation Methods:
Total Marks: 25
Sessional test: 15 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 5 Marks
Class performance/Participation: 5 Marks

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Course prerequisites: To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.
Suggested equivalent online courses:
Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Tenth**
Subject: **Geology**		
Course Code: **B091003T**	Course Title: **Geohydrology**	

Course outcomes: After completing the course, student

- Will know about the hydrological cycle and ground water.
- will aware of conditions which affects the quality and quantity of groundwater.
- will know the methods available for management, restoration of groundwater and how to sustainably utilize it.

Credits: **4**	Core Compulsory
Max. Marks: **25+75**	Min. Passing Marks: **40**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **3-1-0**

Unit	Topics	No. of Lectures
I	Hydrology cycle, Precipitation, Evaporation, Evapotranspiration, Seepage, Infiltration and runoff, Availability of water in the world, Origin of groundwater, Subsurface distribution of water, Springs. Hydrology Properties of Water Bearing Materials: Porosity, Types of porosity, Permeability, Transmissivity, Storativity, Specific yield, Specific retention. Mode of occurrence of groundwater. Classification of rock with respect to their water bearing characteristics, Aquifers, Aquicludes, Aquifuge, Aquitards, Classification of aquifers and groundwater provinces.	15
II	Movement of groundwater: Darcy's law, Reynolds number, and range of validity of Darcy's law, theory of groundwater flow under steady and unsteady conditions, Hydraulic conductivity and Intrinsic permeability, Determination of permeability, Transmissivity and Storativity by discharging pump tests, General flow equation.	15
III	Hydro-geochemistry: Physical and Chemical characteristics of groundwater, Classification of groundwater in respect to domestic, irrigation and industrial use, Pollution of groundwater.	15
IV	Ground Water Exploration and Management: Natural and Artificial recharge of groundwater, Water balance, Analysis of hydrograph, Conjunctive and Consumptive use of groundwater.	15

Suggested Readings:

1. Todd, David K. and Mays, Larry W. (2005): Groundwater Hydrology (3rd edition). Wiley India Pvt Ltd
2. Ward, R.C. and Robinson, M. (1999): Principles of Hydrology (4th edition). McGraw-Hill Education.
3. Chow (1964): Handbook of Applied Hydrology. McGraw-Hill.
4. Raghunath, H.M. (2002): Hydrology: Principles, Analysis and Design. Publisher: New Age International Publishers.
5. Karanth, K.R. (1987): Ground Water Assessment, Development and Management of Water Resources. McGraw-Hill.

This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**

Suggested Continuous Evaluation Methods:
Total Marks: 25
Sessional test: 15 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 5 Marks
Class performance/Participation: 5 Marks

Course prerequisites:
To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent

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bachelor courses from a recognized university/institution.
Suggested equivalent online courses:
Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Tenth**
Subject: **Geology**		
Course Code: **B091004T-A**	Course Title: **Soil Geology**	

Course outcomes: After completing the course, student

- Will understand about the formation of the soil.
- Will learn about the classification of the soil.
- Will learn methods for soil fabric analyses.
- Will understand structures present in the soil.
- Will learn about calcretes, laterite and its significance.

Credits: **4**	Elective
Max. Marks: **25+75**	Max. Marks: **25+75**

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **3-1-0**

Unit	Topics	No. of Lectures
I	Process of Soil Formation, Concept of soil, components of soil, soil profile, pedogenic processes. Classification of soil. Mineral stability of weathering. Soil organic matter form and function.	15
II	Fabric Analysis: Size and shape, Concepts of size and shape, grade scale, methods of analysis, presentation of data, analysis and field grading. Concepts of structure and fabric: Soil fabric, soil structure, soil texture and field grading units. Peds and pedalilty: Size and shape of peds, pedality, primary, secondary and tertiary structures, interpretation.	15
III	Voids: Concepts, size, shape, arrangement and morphological classification. Paleosols: Field recognition, description, origin and causes. Paleosol in stratigraphic records, Significance of paleosol study. Paleosols and human evolution.	15
IV	Calcrete: Definition, classification, calcrete formation, pedogenic calcrete soil profile, macro features in calcretes, micromorphology (petrography), calcretes from Quaternary and ancient sedimentary sequences, significance of calcretes. Laterite: Field and microscopic characters, genesis, Indian occurrences.	15

Suggested Readings:

1. Govinda Rajan, S.V. & Gopala Rao, K.H.G.: Studies of Soils of India.
2. Terzaghi, K. & Pock, R.G.: Soil Mechanics in Engineering
3. Jeffe, J.S.: The A.B.C. of soils.
4. Taylor, D.W.: Fundamentals of Soil Mechanics.
5. Hunt, C.B.: Geology of Soils.
6. Graddy, N.C.: Nature and properties of soils.
7. Gerrard, A.J.J.: Soil and Land forms
8. Wright V. Paul (Editor): Paleosols: their recognition and interpretation. Blackwell Scientific Publication.
9. Wright V.P. and Tucker M.E. (1991): Calcretes. Blackwell Scientific Publication.

This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**

Suggested Continuous Evaluation Methods:
Total Marks: 25
Sessional test: 15 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 5 Marks
Class performance/Participation: 5 Marks

Course prerequisites:
To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.

Suggested equivalent online courses:

Further Suggestions:

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Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Tenth**
Subject: **Geology**		
Course Code: **B091004T-B**	Course Title: **Climatology & Oceanography**	

Course outcomes: After completing the course, student

- Will have basic understanding of the climate and climate change.
- Will have knowledge about the general circulation of the atmosphere.
- Wil understand general weather systems of India and distribution of precipitation.
- Will know the features of ocean floor.

Credits: **4**	Elective
Max. Marks: **25+75**	Max. Marks: **25+75**

Total No. of Lectures-Tutorials-Practical (in hours per week): **L-T-P: 3-1-0**

Unit	Topics	No. of Lectures
I	Climatology, scope, aims and objects, Climate and weather, Insolation, Solar radiation, Heat Budget, Factors affecting distribution of insolation, latitudinal and seasonal variation of insolation, Temperature distribution in the atmosphere, inversion of temperature, Air pressure, its distribution and variation.	15
II	General circulation of the atmosphere, surface wind system, wind belts, humidity, fog and clouds, cloud formation, types of precipitation. Air masses, Monsoon, Jet streams, Coupled ocean-atmosphere system, El Nino Southern Oscillation (ENSO), Cyclones, and Anticyclones, Tropical meteorology: Trade wind inversion, ITCZ; Western disturbances; SW and NE monsoons. Weather elements like thunderstorms, tornadoes.	15
III	Climatic and sea level changes on different time scales, General weather systems of India, Distribution of precipitation over India, Classification of climates, Koppen's and Thornthwaite's scheme of classification.	15
IV	Features of ocean floor: Continental shelf, slope and rise. Physical and Chemical Properties of seawater- Temperature, Salinity, Chlorinity, Density and their spatial variations, T-S diagrams. Residence times of elements in sea water. Ocean currents, waves and tides, important current systems, thermohaline circulation and the oceanic conveyor belt. La Nina, El-Nino Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD). Major water masses of the world's oceans. Biological productivity in the oceans.	15

Suggested Readings:

1. Gross, M. Grant (1977): Oceanography: A view of the Earth. Prentice Hall.
2. Houghton, John (1997): Global Warming. Cambridge University Press.
3. Pinet, P.R. (1992): Oceanography: An introduction to the Planet Oceanus. West Publishing Company.
4. Tolmazin, David (1985): Elements of Dyanamic Oceanography. Allen and Unwin.
5. Trujilo, Alan and Thurman, Harold V. (2019): Essentials of Oceanography (13th Edition). Pearson.

This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**

Suggested Continuous Evaluation Methods:
Total Marks: 25
Sessional test: 15 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 5 Marks
Class performance/Participation: 5 Marks

Course prerequisites:
To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.

Suggested equivalent online courses:

Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Tenth**
Subject: **Geology**		

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Course Code: **B091004T-C**	Course Title: **Gemology**	
Course outcomes: After completing the course, students with expertise in this field • Will have basic idea about gemstones, their formation, identification and evaluation as gemstones are of high commercial values. • Will have knowledge about medicinal gemology as many minerals, rocks and gemstones are also used for crystal therapy.		
Credits: **4**		Elective
Max. Marks: **25+75**		Max. Marks: **25+75**
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: **3-1-0**		

Unit	Topics	No. of Lectures
I	Gem and Gemstones. General characteristics and chemical composition of gemstones: Physical characteristics: Form, cleavage, fracture, hardness and specific gravity. Optical characteristics: colour, lustre, play of colour, refractive index, reflectivity, pleochroism, dispersion.	15
II	Application of ultraviolet rays, X-rays and Infra-red rays in gem identification. Electrical thermal and magnetic characters of gem. Classification of gem stones.	15
III	Systematic description, genesis, mode of occurrence, distribution in India and also important world occurrences of important precious and semi-precious stones.	15
IV	Synthetic gem stones: methods of synthesis, and its characteristics and identification. Gem enhancement methods and their identification: colourless/coloured impregnation, heat treatment, coating, irradiation, diffusion, treatment, etc. Application of gemstones: (1) Technical application and (2) Application as jewels.	15

Suggested Readings:

1. Bauer M. (1968): Precious stones Vol. I and II
2. Bruton E.F.G.A. (1970): Diamonds
3. Orlov Y.L. (1973): The Mineralogy of the Diamond
4. Wilson M. (1967): Gems
5. Brocardo G. (1981): Minerals and Gemstones – An identification Guide.

This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**

Suggested Continuous Evaluation Methods:

Total Marks: 25
Sessional test: 15 Marks
Written Assignment/Presentation/Project / Research Orientation/ Term Papers/Seminar: 5 Marks
Class performance/Participation: 5 Marks

Course prerequisites:

To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.

Suggested equivalent online courses:

Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Tenth**
Subject: **Geology**		
Course Code: **B091005P**	Course Title: **Practical- Geophysics and Geohydrology**	
Course outcomes: After completing the course, student • Will able to determine of velocities and depth of the interface by refraction method. • Will able to estimate the overburden and vertical depth of horizontal layer. • Will learn application of the corrections to gravity data. • Will able to delineate the ore body using gravity and magnetic data and compute gravity effect of a sphere. • Will learn to determine average rainfall, maximum intensity of rainfall for different time durations, hydraulic conductivity and radius of influence of the well for different types of aquifers. • Will understand classification of irrigation water on the basis of SAR and conductivity.		
Credits: 4		Core Compulsory

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Max. Marks: 25+75	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-12	

Unit	Topics	No. of Lectures
	Geophysics: Determination of velocities and depth of the interface by refraction method. Estimation of the overburden and vertical depth of horizontal layer. Application of the corrections to gravity data. Delineation of the ore body using gravity and magnetic data. Computation of gravity effect of a sphere. ***Geohydrology:*** Determination of average rainfall. Determination of maximum intensity of rainfall for different time durations. Determination of Hydraulic conductivity and Radius of influence of the Well for different types of aquifers. Classification of irrigation water on the basis of SAR and Conductivity.	60

Suggested Readings:

1. Chow, V.T. (1964): Handbook of Applied Hydrology. McGraw-Hill.
2. Dobrin, Milton B. and Savit, Carl H. (1988): Introduction to Geophysical Prospecting (4th Edition). McGraw-Hill Education.
3. Gadallah, M.R., Fisher, R. and Fisher, R.L. (2008): Exploration Geophysics. Springer.
4. Karanth K.R. (1987): Ground Water Assessment, Development and Management of Water Resources. McGraw-Hill.
5. Lowrie, William (2007): Fundamentals of Geophysics (2nd Edition). Cambridge University Press.
6. Raghunath, H.M. (2002): Hydrology: Principles, Analysis and Design. New Age International Private Limited.
7. Robinson, Edwin S. (1988): Basic Exploration Geophysics. John Wiley and Sons.
8. Telford, W.M., Geldart, L.P., Sheriff, R.E. and Keys, D. A., (1990): Applied Geophysics. Cambridge University Press.
9. Todd, D.K. and Mays, Larry W. (2005): Groundwater Hydrology (3rd edition). Wiley.
10. Ward, Roy and Robinson, Mark (1999): Principles of Hydrology (4th edition). McGraw-Hill.

This course can be opted as an elective by the students of following subjects: **M.Sc., Physics, Chemistry, Mathematics, Biochemistry, Biotechnology, Microbiology, Environmental Science.**

Suggested Continuous Evaluation Methods: Practical Record: 20 Marks, Class participation and activity: 5, Examination:50 Marks, Viva-voce: 25 marks

Course prerequisites: To study this course, a student must have had passed B.Sc. with any two of the following subjects Geology, Physics, Mathematics, Chemistry and Life Sciences (Zoology and/or Botany) or have passed equivalent bachelor courses from a recognized university/institution.

Suggested equivalent online courses:

Further Suggestions:

Programme/Class: **M.Sc.**	Year: **Fifth**	Semester: **Tenth**
Subject: **Geology**		
Course Code: **B091005R**	Course Title: **Project**	

Course outcomes: After completing the course, student

- Will be able to identify the potential research problem.
- Prepare synopsis of a defined research problem.
- Perform the bench work.
- Interpret the acquired data.
- Prepare the research project report.
- Get exposure of vigorous laboratory training which will help students to boost their research carrier.

Credits: **4**	Core Compulsory
Max. Marks: **100**	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-6

Every student shall be required to undertake Research Project Work and submit a detailed report to the Department Head, with the signature of guide faculty member. The marks awarded for the work shall be on the basis of the submitted research project report, seminar and viva voce.

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