GOVERNMENT ARTS COLLEGE

(AUTONOMOUS)

SALEM-636007

Re-accredited with B Grade by NAAC

[Recognized under 12B and 2F of UGC Act]

(Affiliated to Periyar University)

DEPARTMENT OF GEOLOGY

M Sc APPLIED GEOLOGY

Regulations and Syllabus

(Effective from the Academic Year 2021-2022)

M Sc APPLIED GEOLOGY - REGULATIONS AND SYLLABUS

1. CONDITIONS FOR ADMISSION

The candidate requesting admission to the M Sc Applied Geology program shall have passed the **relevant undergraduate qualifying examination** with all the mandatory courses/subjects as prescribed in the latest Post Graduate Admission guidelines issued by the Higher Education Department, Government of Tamil Nadu through the Directorate of Collegiate Education, Chennai – 6.

2. ATTENDANCE REQUIREMENT

Attendance for theory and practical classes are calculated separately. The attendance for theory classes shall be calculated on the basis of 90 days / 450 instructional hours per semester. For practical examinations the attendance for practical classes shall be calculated on the basis of 180 days / 900 instructional hours by combining the consecutive odd and even semesters for that academic year. The attendance percentage and eligibility conditions for writing the semester examinations for all PG Programs are tabulated below:

Attendance (%)	Category	Eligibility conditions for writing semester examinations
75 and above	Eligible	Candidates are eligible to appear for the theory and practical semester examinations without condonation of attendance.
From 65 to 74	Condonation	The candidate shall be allowed to appear for both theory and practical examinations under the condition that the condonation fees have been paid for both theory and /or practical examinations (as applicable). A candidate who is absent for the theory and /or practical examinations after paying the condonation fees has to apply through proper channel to the Principal and COE for permission to reappear for their lapsed theory and (or) practical papers in the forthcoming semesters.
From 64 to 50	Below condonation	Candidates are NOT allowed to appear for the main semester examinations. He/she has to mandatorily pay the condonation and examination fees in the current semester. He/she may appear for the lapsed papers in the next or subsequent semester after getting the permission from the Principal & COE through proper channel. He/she may appear only for arrear examinations of previous semesters in the current semester provided they have recorded attendance above or within the condonation limits.
At 50 or below 50	Re – do or repeat	Candidates are NOT permitted to appear for the examination. Redo or repeat candidates have to apply through proper channel to the Principal and COE for permission to redo or repeat their lapsed semester. This re-do or repeat clause is bound by the conditions detailed in the Transitory Provision guidelines.

3. EXAMINATION

The maximum mark for each course is 100.The theory examinations shall be of three hours duration conducted at the end of each semester. The candidate failing to get the minimum marks required for passing in any theory course shall be permitted to reappear for each failed theory subject(s) in the subsequent semesters. The practical examinations shall be conducted at the end of even semesters with the duration of four hours. The candidate failing to get the minimum marks required for passing in any practical course shall be permitted to reappear for each failed practical in the subsequent even semesters only.

4. PASSING MINIMUM

The breakup of marks shall be:

<table>
<tr><td rowspan="3">Theory</td><td colspan="5">Continuous Internal Assessment (CIA)</td><td rowspan="2">Semester Theory Examination (SE)</td></tr>
<tr><td>Attendance</td><td>Assignment</td><td>Seminar</td><td>Test(s)</td><td>Total</td></tr>
<tr><td>5</td><td>5</td><td>5</td><td>10</td><td>25*</td><td>75**</td></tr>
<tr><td rowspan="4">Practical</td><td colspan="6">CIA & Main Practical Examinations</td></tr>
<tr><td>Attendance</td><td colspan="2">Practical Tests</td><td>Completion of Mandatory Field Training Program (full attendance on all days), submission of Field Report, and display of collected specimens</td><td>Total</td><td>Semester Theory Examination (SE)</td></tr>
<tr><td>5</td><td colspan="2">10</td><td>25</td><td>40*</td><td>60***</td></tr>
<tr><td colspan="6">* No passing minimum; ** Passing minimum - 38 in SE; *** Passing minimum- 30 in SE</td></tr>
</table>

5. CONTINUOUS INTERNAL ASSESSMENT (CIA) - Attendance Component

Attendance marks for theory courses are as follows:

Attendance percentage	**Marks**
90 to 100	5
80 to 89	4
70 to 79	3
65 to 69	2
At 64 and below 64 (Condonation limit)	1

Attendance marks for practical courses are as follows:

Attendance percentage	Marks
90 to 100	5
80 to 89	4
70 to 79	3
65 to 69	2
At 64 and below 64 (Condonation limit)	1

Assignment Component

Three assignments (with maximum 5 marks for each) have to be submitted for each theory course. The marks of the best two assignments shall be normalized to 5 marks for the assignment component in CIA.

Seminar Component

Two seminars (with maximum 5 marks for each) have to be presented for each semester. The topic of the seminar shall be based on a particular subject assigned by the Teacher or Project Supervisor. The marks of the best two seminars shall be normalized to 5 marks for the seminar component in CIA.

Test Component

Theory

Maximum marks for theory courses in test component are 10. The average marks of CIA Test 1, CIA Test 2, and Model Test mark will be normalized to 10 for each theory course.

Practical

The attendance marks for the Main Practical Exam shall be a maximum of 5 (combining the total attendance recorded in the consecutive odd and even semesters). Maximum marks for the test component of the Practical courses is 10. The average marks of CIA Test 1, CIA Test 2, and Model Practical Test mark will be normalized to 10 for the component mark for each practical course.

A maximum of 25 marks shall be awarded for combined completion of Mandatory Field Training Program (all days), with the compulsory submission of Field Report, and display of collected specimens prior to or at the main practical examination. **Candidates who are absent for the mandatory field program will be awarded zero (0) marks. Candidates who are absent for one or more days for the mandatory field program will also be awarded zero (0) marks if they are unable to provide a factual and acceptable explanation of their absence and submit the same to the Field Coordinators and Head of Department.**

Submission of practical record notebooks with proper ***bona fide*** certificate duly signed by the Staff in Charge prior to the Main practical examination is mandatory for the award for record notebook marks. **Incomplete or forged record notebooks submitted for the main practical examination will be awarded zero (0) marks. Candidates who do not submit their record notebooks for the Main Practical Examination will be awarded zero (0) marks.**

Revaluation

Revaluation of theory courses, re-totaling of marks, supplementary or instant examination, or transparency of Theory courses is permitted as per Government Arts College (Autonomous), Salem-7 Examination Guidelines. Candidates are required to apply to the Controller of the

Examinations, through the Principal with proper endorsement and recommendation by the Head of the department concerned.

Revaluation of Practical courses, re-totaling of marks, supplementary or instant examination or transparency of Practical courses is NOT permitted as per Government Arts College (Autonomous), Salem-7 Examination Guidelines. The candidate has to apply and re-appear for the practical examination at the subsequent even semester only.

DISSERTATION & PROJECT WORK

Each student shall choose his/her project supervisor by the random lot method before the end of first/second semester. The broad field or provisional title for the project shall be assigned to the candidate(s) by their Supervisors and a list of the same shall be submitted to the Head of Department. **The list finalized and approved by the Head of Department is binding, final and non-negotiable.**

Plan of Work

The student(s) shall prepare a viable plan of work for the dissertation and get the approval of the Supervisor(s). The student(s) should start the project work from the end of the first/second semester and submit the project report at the time of viva-voce examination at the end of the fourth semester. The mandatory periodic reviews of the work progress of the student(s) will be monitored by the Supervisors and Head of Department. The project report shall be duly certified by the Supervisor and the Head of the Department. Students who secure sponsored projects from outside agencies, e.g. TANCSHE and others may submit the same as the regular project work for the viva with the written approval of the Supervisor and Head of Department.

Dissertation work outside the College

In case the student(s) needs to avail facilities outside the college, (i.e.) from other University / Laboratory, they shall pursue the work with the approval and permission of both the Supervisor and the Head of Department and properly acknowledge the outside facilities utilized by them. The student shall complete the project work on or before the commencement of the Main Practical examinations or a specified date of the calendar year, which ever comes first. Mandatory approval/permission of the College Principal/DCE shall be obtained when the student works for his/her project outside the College for a period exceeding more than consecutive four weeks or twenty eight days (excluding Government holidays).

Submission of Dissertation

The student shall prepare 2 copies of the project work and submit the same at the time of viva – voce, for evaluation by the Examiners. After evaluation, a soft copy of the dissertation is to be submitted to COE and Department Library.

Marks for Dissertation

The total marks for dissertation shall be 200, of which 150 marks are for project work and 50 marks for viva-voce. All relevant regulations for the end semester practical are applicable to this course.

6. CLASSIFICATION OF SUCCESSFUL CANDIDATE

The performance of the student is indicated by the Grades, the corresponding Grade Point (GP), Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA). A student is declared to have completed the course successfully and earned the appropriate credits, only if the said **candidate has earned a grade of C and above**. **RA denotes the candidate should Re-Appear for the examination.**

GP = (Marks obtained in a course x Credit) / 10
GPA =Total Grade points earned in a semester/Total Credits registered in a semester
CGPA = Sum of Grade Points earned / Sum of Credits registered

Classification of Cumulative Grade Point Average (CGPA)

Grade	Cumulative Grade Points Average (CGPA)	Grade Description	Class Obtained	Range of Marks
O	9.0-10	**Outstanding**	**I CLASS-DISTINCTION**	90-100
E	8.0-8.9	**Excellent**		80-89
D	7.5-7.9	**Distinction**		75-79
A+	7.0-7.4	**Very Good**	**I CLASS**	70-74
A	6.0-6.9	**Good**		60-69
B	5.0-5.9	**Satisfactory**	**II CLASS**	50-59
RA	4.9 and below 4.9	**Re-Appear**	NA	49 and less than 49
ABSENT	0.0	**ABSENT**	NA	ABSENT

7. QUESTION PATTERN

The question pattern for theory courses shall be as follows:

Duration of examination: 3 Hours; Maximum Marks: 75

Part A: 15×1=15 Marks

15 Objective Type Questions. All the question are to be answered. Three questions from each unit will be set. All the questions will carry equal marks. There will be no internal choice.

Part B: 2×5 = 10 Marks. Five questions will be set with one question from each unit. Of the 5 questions, any two is to be attempted or answered. All the questions will carry equal marks. There will be no internal choice.

Part C: 5×10 =50 Marks. Five questions will be set with one question from each unit with internal choice. All the question are to be answered. All the questions will carry equal marks. There will be no internal choice.

The question pattern for practical courses shall be as follows:

Duration of examination: 4 Hours; Maximum Marks: 60. No. of questions will vary with Practical and there is no internal choice. Maximum marks = 50 Marks; Record = 10 Marks; **Total Marks = 60 Marks.**

8. INTERNSHIP & TRAINING

Students are compulsorily required to apply for and attend internship and training programs in geology related State & Central Government concerns as a part of their M.Sc Applied Geology Program. The duration and time of internship will be based on the concern or agency offering the internship/training.

9. RANKING

Candidates who have passed all the examinations prescribed for the course **in the first appearance only are eligible for ranking**. A candidate who is **absent** for one or more courses in a semester examination and who later appears for the same course or courses in the subsequent semester examination **is NOT eligible for ranking** even though he/she has completed the course within two academic years / eight semesters from his/her year of admission.

10. COMMENCEMENT OF THIS REGULATION

This regulation shall take effect from the academic year 2021-2022. The students admitted to the first year of PG programme from 2021-2022 and thereafter shall follow these regulations.

11. TRANSITORY PROVISION

The duration for completion of a PG programme in any subject is consecutive four Semesters. The maximum period for completion is consecutive eight Semesters. **Thereafter they will be permitted to appear for examination only under the syllabus and regulations then in force**. It is mandatory for the candidate to inform the Controller of Examinations and Principal and get written permission from them to appear for their arrear courses after the transitory provision has lapsed in their case.

12. ACADEMIC COUNCIL RATIFICATION AND APPROVAL

These guidelines and regulations will be effective from the academic year 2021-2022. Any changes to these guidelines and regulation will be subject to the ratification and written approval of the Academic Council. Any subsequent changes may be done by the BOS after written permission / communication from the Academic Council. The changes are to be put up with justification for ratification and written approval of the Academic Council. These guidelines and regulations are the property of Government Arts College (A), Salem 636007.

VISION & MISSION OF OUR GEOLOGY DEPARTMENT

About our Geology Department

Our Geology Department was started in 1963 offering B.Sc Geology as a three year course and the two year M.Sc Geology course was introduced in 1978 both under the non – semester system. The affiliation changed to Periyar University from 1997-98 and the course was renamed as Applied Geology. Our Department officially became a research department by offering M.Phil and

PhD degrees from 2006-2007 based on the guidelines and framework issued by Periyar University. The Department has a museum with more than 1500 rock, mineral, crystal models, and fossil specimens. We have separate laboratories for microscopy, survey, geochemistry & geophysics, and remote sensing. A library with more than 2500 books is available in our Department. Inflibnet and NLIST facilities are also available with their recommended e-books (texts and reference) in the library.

VISION

Our Geology Department objectively aims to constantly strive, achieve, and maintain a worthy and commendable position in the field of geology. We endeavor to accomplish this in our students by imparting, disseminating, participating, and contributing knowledge, skills, and rational values with a local, national, and global perspective, to them.

MISSION

Our mission objectives are: To provide, promote and sustain an enriching and transformative educational experience for our students with a strong foundation of basics and applied knowledge in the geological sciences. To promote relevant pedagogical and research practices within and outside the department to enable our students to think critically, visualize and synthesize ideas with originality and application. To impart and imbibe in them, necessary skills like problem-solving, communication, interpersonal, and leadership skills which they may transfer to their job or vocation that they wish to pursue. To engage actively with relevant stake holders and society in general, via participation, co-operation, and consultation outside the traditional borders of the department, locally, nationally, and globally.

Programme Educational Objectives (PEOs)

The following constitute the PEOs for the Master of Science program in Applied Geology offered by the Department of Geology, Government Arts College (A), Salem – 636007. Applied Geology is the combination of pure geology courses with other courses which overlap with physics, chemistry, mathematics, computing, and engineering such as geophysics, geochemistry, geostatistics, mining geology, mineral exploration, remote sensing, engineering geology and others.

Like Geology, Applied Geology is a field oriented programme with mandatory field training/internships throughout the duration of the course. The course offers a viable scope for job opportunities or consulting work in geology or options in non-geological fields, after the completion of the post graduate degree. Progression to higher degrees is an option for those who want to continue their education for which the post graduate degree qualification is eligible for the varied and relevant job opportunities.

PEO1	The Master of Science Applied Geology program aims to expand, increase, strengthen and usefully broaden the knowledge acquired at the undergraduate level with reasonable scope for progression to higher degree programs and jobs relevant to the course.
PEO2	The student is introduced to the different components of the earth system including its composition, and operative processes active in the geological past and present in order to understand the different times scales of geological processes.

PEO3	The student acquires an advanced and in depth theoretical and relevant practical framework for understanding the nature and origin of different types of geological materials – rocks, minerals, fossils, and fluids.
PEO4	The student learns to understand and apply established fundamental scientific principles using relevant interdisciplinary skills in physics, chemistry, biology, mathematics, computing, engineering and others.
PEO5	The student learns to apply the knowledge of the different earth materials and related geological processes in geological mapping, mineral and fuel exploration, groundwater exploration, environmental assessments, natural disasters, mining geology, engineering geology and others.
PEO6	The student also learns to visualize, synthesize, apply and integrate field work observations with theory via practical knowledge and skills acquired in the class room and laboratory in order to describe natural geological processes.

Programme Specific Outcomes (PSOs)

As Applied Geology is partly interdisciplinary, the student is provided with courses which bridge both geology and other natural sciences as geophysics, geochemistry, remote sensing, palaeontology, and others. The broad course objectives and teaching methodology are outlined under the appropriate courses and papers. After the successful completion of the Master of Science in Applied Geology program the student acquires the following programme specific outcomes (semester wise):

PSO1	In the **first semester**, students acquire knowledge of the advanced concepts and applied components of Mineralogy, Geomorphology, and Paleontology & Stratigraphy. There are two major based electives for this semester: Petroleum Geosciences and Geology of Tamil Nadu. Petroleum Geosciences has been designed to include advanced topics relevant to petroleum industry exploration practices. The Geology of Tamil Nadu paper is detailed with updated and relevant topics for field geology, mapping, and competitive examinations.
PSO2	In the **second semester**, they are introduced to advanced topics in Structural Geology & Geotectonics, Economic Geology & Mineral Economics, and Exploration Geophysics. There are two major based electives for this semester: Mineral resources of India and Problems in Geology for competitive examinations. The Mineral resources of Tamil Nadu elective deals with relevant and updated topics as per its title. The Problems in Geology for competitive examinations elective deals with the relevant geology based mathematical problems as per its title. There are two practical papers common to both semesters: the first practical is concerned with Structural Geology, Stratigraphy, Remote Sensing & GIS; and the second practical with Advanced Crystallography & Mineralogy. The mandatory field programs for the first year emphasize either geological mapping or field based study of important geological formations. The student gains a working knowledge of identifying, assessing, and recognizing the different geological materials, handling field instruments and equipments, mapping the varied features, structures and others, in the field with emphasis of their origin and configuration. The student can map the field data for practice and later use in their project or other related work. He/she can identify, interpret, and critically evaluate existing geological maps. The project work component is initiated after confirmed admission of students at the start of the second semester.

PSO3	In the **third semester**, students acquire knowledge of the advanced concepts and applied components of Igneous & Metamorphic Petrology, Sedimentary Petrology & Sedimentology, and Hydrogeology. There is an interdisciplinary course titled Industrial Chemistry & Geochemistry this semester common to both Chemistry & Geology departments.
PSO4	In the **fourth semester**, they are introduced to advanced topics and applied components in Mining Geology & Ore Dressing, Engineering Geology & Environmental Geology, and Remote Sensing & GIS. There are two practical papers common to both semesters: the first practical is concerned with Petrology, Mining Geology & Hydrogeology. The mandatory field programs for the second year emphasize either geological mapping or field based study of important geological formations. The student gains a working knowledge of identifying, assessing, and recognizing the different geological materials, handling field instruments and equipments, mapping the varied features, structures and others, in the field with emphasis of their origin and configuration. The student can map the field data for practice and later use in their project or other related work. He/she can identify, interpret, and critically evaluate existing geological maps. The project work component is common for the third and fourth semesters.

Programme Outcomes (POs)

The student graduating with the degree of Master of Science program in Applied Geology should be reasonably able to acquire a solid foundation with a working and transferable knowledge in the science of Applied Geology within and outside of its different courses. He/she should be able to:

PO1	Demonstrate a working knowledge of the terminology of geology, geophysics, geochemistry, and others, with a comprehensive understanding of the earth's interior, surface, resources, climate, biosphere, and the different methods used to study them.
PO2	Identify with confidence the different minerals, rocks, ores, and fossils in the field or outcrop or laboratory, based on their megascopic and microscopic characters and natural crystals based on their morphology along with a working knowledge of their geological origin and significance.
PO3	Identify with confidence the different geomorphic features and geological structures in the field and map with emphasis of their origin and configuration.
PO4	Identify, interpret, synthesize and evaluate topographic and geological maps, terrain models, draw profiles and geological cross sections.
PO5	Identify, interpret, visualize, synthesize and evaluate geophysical data, geochemical data, and remote sensing images.
PO6	Apply the acquired knowledge to mineral and fuel exploration, mine planning and mining geology, remote sensing geology and engineering geology.
PO7	Apply and handle Brunton and clinometer compasses, different surveying equipment, geophysical surveying equipment, remote sensing images, topographic maps, terrain models, and others in geological mapping, mineral exploration and other geological investigations.
PO8	Apply the relevant principles of chemistry, physics, mathematics, computing and engineering to varied geological problems.
PO9	Discuss with confidence the theories and principles for major processes, phenomena and observations within Applied Geology. Synthesize recorded observations, evidences and theory

	across different areas of earth and planetary science, recognising and explaining similarities and differences between different regions, times, planets and geological processes.
PO10	Develop proficiency in understanding and conveying complex geological ideas and concepts with clarity in written, online and oral communication and to develop positive values and aptitude necessary to obtain and maintain employment as a professional geologist or to further their education.

Graduate Attributes

Characteristic attributes relevant to a post graduate in Applied Geology are:

Education and Training	To acquire education and training of the highest quality in Applied Geology in a stimulating and supportive learning environment. This is to ensure and promote a deep and systematic understanding of core areas and advanced topics in the study of the Earth, and its evolution as a planet. To perceive Applied Geology as an essential component of our culture, promoting human development and sustainability through the search for energy sources, raw materials, water supplies, sites for safe waste disposal, mitigation of natural hazards and others. To acquire scientific expertise and advanced equipment to develop skills in gathering and interpreting the geological and geophysical data to equip students with the foundations for their professional careers or additional study. To confidently prepare for a career in professional practice in industrial or environmental sciences, research in Applied Geology, and specialist areas of other physical and natural sciences. To gain relevant transferable skills to graduates for non – geological science based industries, commerce, public service and academics, particularly those which need to be communicated by the methodology of a broad range of physical and natural science.
Communication Skills	To independently formulate and express clearly, ideas and arguments, both orally, in writing, presentations, and in other forms of electronic media of a given topic. To develop skills to communicate to different audiences and in different situations, ranging from scientific and industry reports, to group and individual oral presentations, blogs, outreach articles, news articles, online e- learning tools, dissertations and essays. To do research and present work as an individual or as a group member and to develop skills to participate actively in group discussions and seminar presentations.
Critical Thinking, Problem Solving & Analytical Reasoning	To develop the ability to understand and evaluate primary evidence critically; and to present arguments and solutions based on primary data and theory; and to advance the limits to our present knowledge of the Earth, its processes and their mutual interactions. To acquire an understanding of the concepts in applied geology and related disciplines with the ability to understand, visualize, synthesize, numerize, and extend it so that all fundamental geological concepts are accessible. To acquire, digest and critically evaluate scholarly arguments, the assumptions behind them, and their theoretical and empirical components. To apply knowledge of the fundamentals of chemistry, physics, biology and mathematics needed to provide insight into these Earth processes. To develop competency in both field and laboratory skills, and in data analysis, interpretation and presentation that lead to the successful pursuit of pure or applied problems in geology.
Scientific Reasoning &	To develop a systematic understanding of both core areas and advanced topics in the study of the Earth, its materials and structure, and the processes that have

Research Related Skills	controlled its evolution as a planet. To provide for student interaction with high-level scientific expertise and advanced equipment in an environment committed to scientific advance. To develop the ability to evaluate primary evidence critically; and the conceptual understanding to present arguments and solutions based on primary data and theory. To promote an appreciation of the limits to our present understanding of the Earth, its processes and the interactions between them. To acquire skills to recognise and articulate a problem and then apply appropriate conceptual frameworks and methods to solve it with emphasis placed on integrated problem-solving exercises, where students are taught on how to process complex data sets using a diverse range of skills and knowledge. This provides the foundation for student-led independent, with academically directed, project work. To develop the ability to apply knowledge and understanding to address familiar, unresolved and more open-ended problems along with the ability to choose and formulate an original problem topic based on the scientific method. This is subsequently followed by a rational plan of work to be done progressively or in stages. To develop the skill to process and interpret large and complex primary datasets with a set hypothesis and test, and to function as a numerate, literate scientist able to prove insight and guidance related to real-world problems and issues. To develop the skill to collect, analyse, synthesise, summarise and inter-relate diverse processes and facts, to formulate and test hypotheses, reach conclusions and publish the findings as a research paper.
Team Work	Ability to contribute effectively to team objectives and interact productively with others both in project-related settings and in meetings. This is addressed through group exercises in all years of the Applied Geology programme, including in-class presentations, group lab-sessions where students use research equipment, presentations to panels of outside industry experts, group fieldwork and mini-projects.
Self and Time Management & Digital Literacy	Active participation with the assessment process for the duration of the course orients a student to manage time for themselves to meet the mandatory course requirements. The student is encouraged to make ample time for understanding the taught materials, prepare their own notes, understand the idea of exam wiseness, revise and over learn prepared materials, practice problems with understanding and receive feedback to further their progress. A knowledge of study methods applicable to science and maths is desirable. They are also encouraged to learn and plan on how to distribute their work through out the semester(s) to meet different course deadlines for submission of records, assignments, continuous assessment material, and all other course related work. They also need to prepare a working and flexible study plan or time table to confidently prepare for end of semester examinations. Participation in different extracurricular activities is encouraged and suggested to be planned and done without disturbing the normal routine of course work throughout the semester. Time management learned during students days are habit forming and transferable skills for future progression to higher studies or a job. Learning to code using python, ‘r’ language, perl, and others, to use them for their learning and project work is desired. These can be initiated via Swayam online courses and others recommended by the teachers. Acquirement of essential skills in word processing, GIS, statistics, databases, spreadsheets, digital drawing through online workbooks and workshops, and to use digital resources for presentations are useful.
Moral and Ethical Values &	The student is encouraged to follow ethical behaviour by adopting objective, unbiased, and rational decisions in all aspects of their student life and future work.

Leadership	Undesirable practices like fabrication, falsification or misrepresentation of data, plagiarism, not adhering to intellectual property rights, are patently discouraged. Adherence to rational moral values is desirable in the long run and in all walks of life. Leadership qualities are learned by cooperation and active participation in different forms of group activities like field work, mini-projects, extracurricular activities, and others. Leadership qualities are learnt in the long run and are an extension of rational moral and ethical values.
Life-long Learning & Global Competency	After completing course in Applied Geology, the student is expected to be reasonably knowledgeable about the subject, able to think independently, gather relevant facts, discuss subject topics, and to apply practical skills learnt in the classroom/laboratory to actual field conditions with reasonable confidence. To progress to higher education or transition to a job after the successful completion of their course, students are encouraged to be a life long learner to keep him/her self up to date on their acquired knowledge and skills. The ability to synthesize academic and practical skills which are transferable to other domains of one's life and work is desirable for progress. He/She will be ready to accept challenges and stand in competition at a national and global level.

CAREER PLANNING

Geology and Applied Geology are primarily field oriented subjects. Geologists carry out regular field work in seasons followed by office work involved in writing out reports of the field season. Field work in the academic course of study is limited as there are more theoretical and practical aspects to be understood prior to field training. The material learned in practical are realized in field work or some job related skill. In PG geology courses, students are exposed to places of geological importance in compulsory educational field programs.

Intrinsic interest and understanding is enhanced by applying class room topics to real field conditions. Seeing and understanding things at different angles with an inquiring mind are essential and need to be practised. The following skills are taught: methodological observation of geological features, practical application of a laboratory skill to field situations, visualization of hidden geological features and application of scientific method: method of deduction and induction to allow proper inference of results from collected and available field data. The taught skills are written as a report and submitted during practical exams for evaluation.

To attain the above prerequisites a student must develop an intrinsic motivated interest in the chosen field, involvement in the subject by asking questions, getting clarifications so as to understand basic concepts and principles thoroughly, and acquiring mastery over the relevant practical aspects.

Career planning is an important aspect of student life but is ignored by most students. Job openings today require some form of written test followed by an interview prior to appointment. Job options and openings regularly change depending on vacancies available, qualification, experience or training, and salary offered. Career planning involves goal setting: both long and short term. Long term goals lead to a career choice(s) and appointment, while short term goals allow continuous acquisition of necessary skills for the job: subject qualification and knowledge application in the future job, training, competency skills, soft skills, and prior preparation for different competitive exams.

All career goals involve competition among peers, internal and external compulsions during the actual job search, salary range available, place and type of work, and others. The student is

advised to be aware of changing and new job related information regularly by proper and established avenues: newspapers, net based web content, official sources and others.

Students should carefully plan their career goals so that they can be achieved by reasonable effort and hard work. Flexibility in planning is advised to accommodate changes in job prospects and vacancies. Changing job scenarios such as limited vacancies, over competition for limited posts, etc. should not discourage students with a rational career plan. **Career plans must never underestimate or impede the student's potential for progress and achievement.** Application and knowledge of interviewing skills along with demonstrated interest in one's own discipline is recommended.

Today's job opportunities stress interpersonal skills, emotional and social intelligence skills (a part of soft skills) as a more reliable criterion than academic qualifications or intelligence. Ethical and job related values are imbibed in the rational values a person learns and uses throughout one's life. A demonstrated ability of discipline, hard work, and integrity, and a disinterest in irrational values are seen as exemplary reasons for appointment and are ably tested in all types of personality tests and interviews (including group discussions, psychological tests, and psychometric tests). All students should be aware of this. The academic criterion should demonstrate depth of understanding and application of knowledge by disciplined hard work and effort which is a manifestation of rational values mentioned above. Students should not be fooled by unethical short term skills and shortcut methods.

Planning one's career after completing the PG degree is costly in terms of lost or wasted time and re-preparation for competitive exams. Students become frustrated when their skills and qualifications do not measure up to the real competition for limited jobs. Age is a factor for applying and there is always an age limit for recruitment to some job vacancies. This invariably results when students procrastinate and put off career planning still late after acquiring the PG degree. Career planning should be initiated and charted out early, i.e. before admission or in the first year of study and must be followed up till appointment.

Career planning should be flexible to changing job prospects and environment. Knowledge of competitive exams relevant to the chosen discipline is useful. Collecting relevant material such as old question papers, texts, syllabi, etc. of different competitive exams is suggested. The study schedule may be adjusted to incorporate preparation for competitive exams. The idea of exam wiseness is emphasized here also. Career choices and information of most competitive exams can be obtained from their Tutors or Course Teachers. Discussing career goals with teachers, parents, and professionals will allow the student to chart the career choices and goals in his or her future. Acquiring job related and work related soft skills are essential in the long run.

The job openings relevant to geological sciences require a first class PG degree and are mainly directed towards the mining industry, oil exploration companies, mineral exploration and geological mapping. Allied fields include: ground water management, remote sensing, seismology, engineering geology, and others. Research positions are available for interested students with an academic bent of mind in several CSIR institutes. Teaching positions require additional qualification and training prior to appointment.

Career Options after M.Sc. Degree in Applied Geology

The following list is not exhaustive but a starting point for future planning of one's career. Advertisements for recruitment are published in major newspapers and in job related websites. Some opportunities may be arranged by a strong alumni network or through teachers, friends, and others. Each job opening should be given due consideration before deciding to apply. Application to

any job should be prompt with follow up: follow up to any chosen job or vocation prior to regular appointment is essential. The number of openings is generally variable with backlog vacancies or addition of new posts. Some recruiters require GATE or CSIR qualification to mandatory for applying to an opening in their concern.

1. UPSC Geologists' Examination: recruitment to GSI and Survey of India. (www.gsi.gov.in).
2. Recruitment to NMDC, BARC, ONGC, MECL, ISRO-SAP, MMCI, HCL, HZL, CGWB, NABARD, NLC, CIL, BGM, IBM, NTPC, UCI, CSIR Institutes, NRSA, DRDO,DRO, etc. through UPSC selection or by direct recruitment by an entrance test (GATE) and interview.
3. Recruitment to private concerns: ACC, JINDAL, MALCO, INDAL, Essar, Reliance, Shell, Rio Tinto, Schlumberger, OFI, Chevron, Exxon, Cairn, etc.
4 Private consultancy: granite exploration, mine planning consultant, remote sensing, ground water prospecting, mineral exploration and mapping, and exploration geophysics. This may require qualification in specialized courses: M. Tech degree in the relevant discipline. Some jobs may require experience and qualification as RQP (from Indian Bureau of Mines).
5. Recruitment to SM&G, PWD, TWAD, TAMIN, TANMAG, etc. through TNPSC written exam and interview. (www.tamin.gov.in).
6. UPSC – IAS and IFS. (www.upsc.gov.in).
7. GATE qualification through GATE exam conducted by IITs to apply and get admitted to geology related M.Tech programs with scholarship and tuition waiver. (www.iitb.ac.in)
8. JRF or Lectureship qualification through CSIR - UGC accredited NET, SLET or SET examination.
9. Non GATE geology related M.Tech courses offered in various Indian Universities.
10. Research Associate or JPF post (temporary) in DST sponsored projects in Universities and Colleges.
12. GRE, IELTS and TOEFL qualification to pursue higher degrees in foreign countries. Students desirous of pursuing higher studies abroad may visit official websites of foreign universities for first hand information and contacts. They may also attend education seminars conducted by different Foreign Consulates and Embassies for information. Alternately, they may contact **government recognized educational consultants** for procedure and process of applications. Advertisements for education seminars and related information can be noted in national newspapers.
13. Recruitment in MNC Oil companies in the Gulf States and countries.
14. Academic M.Phil and PhD degrees through CSIR NET JRF or GATE or by JPF in sponsored projects in approved College and University Departments.
15. Geological data processing by WIPRO, TCS, CTS, etc.

16. Registration at Overseas Manpower Corporation, Chennai: www.omc.manpower.com, ovemcl@gmail.com, to apply and receive information on employment in developing countries.

References for Career planning & Study methods.

1. Race, P. (1998). How to get a Good Degree. Viva Books Ltd. Chennai.

2. Barnes, R. (1992). Successful Study for Degrees. Routledge India Pvt. Ltd. New Delhi.

3. Barass, R. (2002). Study. Foundation Books India. New Delhi.

4. Albuquerque, U. (2005). Handbook of Careers: Volumes I & II. Penguin India Ltd, New Delhi.

5. Anon. (2018). List of Scholarships: Indian & Foreign. SAP Publications. New Delhi.

DEPARTMENT OF GEOLOGY
GOVERNMENT ARTS COLLEGE (A), SALEM 636007
CURRICULUM ABSTRACT OF M.Sc APPLIED GEOLOGY
2021-2022

Category	No. of Courses	Total credits
CORE COURSE – THEORY	12	60
CORE COURSE – PRACTICAL	4	18
MAJOR BASED ELECTIVE COURSES (MBE)	4	8
RESEARCH ACUMEN COURSES (RAC)	3	0
INTERDISCIPLINARY COURSE	1	2

PROJECT WORK		12
Total	**24**	**100**

Total number of Courses: 24
Total Credits: 100
Cumulative Total Marks: 2400

M.Sc APPLIED GEOLOGY 2021-22 COURSE OF STUDY & SCHEME OF EXAMINATION

S. No	Course Code	TITLE OF THE COURSE	H@	C	Marks		
					IA	SE	Max
FIRST SEMESTER							
1	**21PGL01**	**CC – I: Advanced Mineralogy**	**5**	**5**	**25**	**75**	**100**
2	**21PGL02**	**CC – II: Applied Geomorphology**	**5**	**5**	**25**	**75**	**100**
3	**21PGL03**	**CC – III: Stratigraphy & Paleontology**	**5**	**5**	**25**	**75**	**100**
4	**21PGLP1**	**CP– I: Structural Geology, Stratigraphy, Remote Sensing & GIS**	**5**	**PRACTICAL EXAM WILL BE CONDUCTED IN EVEN SEMESTER**			
5	**21PGLP2**	**CP-II: Advanced Crystallography & Mineralogy**	**5**				
6	**21PGLM1**	**MBE I Petroleum Geosciences**	**3**	**4**	**25**	**75**	**100**
	21PGLM2	**MBE II Geology of Tamil Nadu**					

7	**21RAC01**	**RAC I: Intellectual Property Rights**	**2**	**Non Credit Course**		**100**	**100**
		TOTAL	**30**	**19**			**500**
SECOND SEMESTER							
1	**21PGL04**	**CC – IV: Structural Geology & Geotectonics**	**5**	**5**	**25**	**75**	**100**
2	**21PGL05**	**CC – V: Economic Geology & Mineral Economics**	**5**	**5**	**25**	**75**	**100**
3	**21PGL06**	**CC – VI: Exploration Geophysics**	**5**	**5**	**25**	**75**	**100**
4	**21PGLP1**	**CP– I: Structural Geology, Stratigraphy, Remote Sensing & GIS**	**5**	**4**	**40**	**60**	**100**
5	**21PGLP2**	**CP-II: Advanced Crystallography & Mineralogy**	**5**	**4**	**40**	**60**	**100**
6	**21PGLM3**	**MBE-III: Problems in Geology for Competitive Examinations**	**3**	**4**	**25**	**75**	**100**
	21PGLM4	**MBE-IV: Mineral Resources of India**					
7	**21RAC02**	**RAC II: Research Writing***	**2**	**Non Credit Course**		**100**	**100**
		TOTAL	**30**	**27**			**700**
		CUMULATIVE TOTAL		**46**			**1200**
THIRD SEMESTER							
1	**21PGL07**	**CC – VII: Igneous & Metamorphic Petrology**	5	**5**	25	75	100
2	**21PGL08**	**CC – VIII: Sedimentary Petrology & Sedimentology**	5	**5**	25	75	100
3	**21PGL09**	**CC – IX : Hydrogeology**	5	**5**	25	75	100
4	**21PGLP3**	**CP – III: Petrology**	5	**PRACTICAL EXAM WILL BE CONDUCTED IN EVEN SEMESTER**			
5	**21PGLP4**	**CP – IV: Mining Geology & Hydrogeology**	5				
6	**21PCHGL**	**IDC – Industrial Chemistry & Geochemistry**	2	**2**	25	75	100
7	**21PGLPR**	**PROJECT WORK (to be continued in Semester IV)**	3				
		TOTAL	**30**	**17**			**400**
		CUMULATIVE TOTAL		**63**			**1600**
FOURTH SEMESTER							
1	**21PGL10**	**CC – X: Mining Geology & Ore Dressing**	5	**5**	25	75	100
2	**21PGL11**	**CC – XI: Engineering Geology & Environmental Geology**	5	**5**	25	75	100

3	**21PGL12**	**CC – XII: Remote Sensing & G.I.S.**	5	**5**	25	75	100
4	**21PGLP3**	**CP – III: Petrology**	5	**5**	40	60	100
5	**21PGLP4**	**CP – IV: Mining Geology & Hydrogeology**	5	**5**	40	60	100
6	**21RAC03**	**RAC III: Research and Publication Ethics**	2	**Non Credit Course**		100	100
7	**21PGLPR**	**PROJECT WORK**	3	**12**	50	150	200
		TOTAL	**30**	**37**			800
		CUMULATIVE TOTAL	120	**100**			2400

H[@] – Hours per week/timetable cycle/six day order cycle; C – Credits; IA – Internal Assessment; EA – External Assessment; IDC – Interdisciplinary Course

Enrolment in a minimum of one PG Non-Engineering MOOC Courses relevant to their subject offered through SWAYAM platform is mandatory. The students can enrol after getting permission from the Head of the Department. The students must obtain 40% marks in internal assessment. The student who wishes to get course completion certificate must necessarily enrol and pass in the examination conducted through SWAYAM platform.

Course Code	Paper Title	Lectures	Tutorials	Practical	Credits
21PGL01	ADVANCED MINERALOGY	4	1	5	5

Broad Objectives & Teaching Methodology:

Advanced Crystallography is a core part of mineralogy. It is the study of the morphological characters of crystals. It also extends to how these characters are related to its classification, lattice types, atomic structure, chemical composition, physical and optical properties. Mineralogy is essential for understanding petrology, economic geology, field geology, mining geology, exploration geology, other courses in Applied Geology.

The study of mineralogy also extends to meteorite petrology and other planetary materials. Physical and chemical characters of minerals find use in geophysics and geochemistry. The proper identification of minerals in the laboratory or in the field, is a precursor to assess the rock types in which they occur. The student is introduced to the different mineral groups emphasizing their overall morphological properties for megascopic and microscopic thin section identification, and their mode of occurrence to observe and evaluate their distribution in different earth materials. Optical mineralogy is discussed for practical application in mineral microscopy.

The teaching methodology is done by class room lectures, use of physical models, multi media resources, interactive sessions, student involvement sessions with practical and laboratory demonstrations, field visits, microscopic techniques and others.

UNIT I

Advanced Crystallography: Symmetry elements in crystals. Concept of Point & Space Groups. Space Lattice: definition, types, features, derivation of the 14 Bravais lattices. Outline of derivation of 32 Classes of crystals. Short introduction to Schoenflies and Hermann- Mauguin notation. Spherical and Stereographic projections: application and utility in crystallography. X Ray Mineralogy: Bragg's law; Laue method & Powder method and their applications and limitations.

UNIT II

Study of Mineral Groups I: Detailed description of the physical, chemical and optical properties with a note on internal atomic structure and mineral paragenesis of the following rock forming silicates: Olivine Group - Garnet Group - Epidote Group - Scapolite Group - Feldspathoid Group - Spinel Group - Quartz Group. Crystal defects: Different types of macro and micro scale surface and internal defects.

UNIT III

Study of Mineral Groups II: Detailed description of the physical, chemical and optical properties with a note on internal atomic structure and mineral paragenesis of the following rock forming silicates: Feldspar Group - Pyroxene Group - Amphibole Group - Mica Group - Zeolite Group - Chlorite Group. Crystal Twins: Definition - symmetry elements: twin axes - twin planes - composition planes. Laws of Twinning. Types of Twins.

UNIT IV

Optical mineralogy I: Characters of Isotropic minerals under the polarizing microscope. Characters of Uniaxial minerals: definition - birefringence - indicatrix - optic axis - properties observed under parallel & crossed Nicol conditions. conoscopic study of uniaxial minerals: interference colour & figure - optic sign.

UNIT V

Optical mineralogy II: Characters of Biaxial minerals: definition - optical directions - indicatrix - optic axes - properties observed under parallel & crossed Nicol conditions. conoscopic study of biaxial minerals: interference colour & figure - optic sign. use of mica plate, gypsum plate and quartz wedge. Application of Michel - Levi interference colour chart. Sign of elongation.

REFERENCE BOOKS

1. Bloss,F.D. (1971). Crystallography & Crystal Chemistry. Holt, Rinehart & Winston. New York.
2. Bishop,A.C.(1967). An Outline of Crystal Morphology. Hutchinson. London.
3. Whittaker,E.S.W.(1981). Crystallography. Oxford University Press. London.
4. Phillips,F.C., (1965). Crystallography. ELBS. London
5. Deer, W.A.,et al.(2013). Introduction to the Rock Forming Minerals. ELBS, London.
6. Klein,C & Hurlbut,C.S, (1985). Manual of Mineralogy. Wiley & Sons.
7. Hutchinson,C.S.,(1974) Laboratory Handbook of Petrographic Techniques. Wiley. Delhi.
8. Phillips, Wm, R. and Griffen, D.T., (1986). Optical Mineralogy. CBS Delhi.
9. Phillips,Wm,R. (1980). Mineral Optics, McGraw Hill, New York.
10. Stoiber, R.E. & Morse.S.A. (1994). Crystal identification with the Polarizing Microscope. Springer. Delhi.

TEXT BOOKS

1. Senguptha,S.(1980). Crystallography and Optical Mineralogy. EW Press. Delhi.
2. Berry,L.G. & Mason,B. (1983). Mineralogy. CBS Publishers, Delhi.
3. Kerr, P. F., (1977). Optical Mineralogy. McGraw Hill. New York.
4. Nesse,W. (2004).Introduction to Optical Mineralogy. Oxford University Press. New Delhi.
5. Blackburn,W.H. & Dennen, W.H. (1994). Principles of Mineralogy, WCB Publishers. USA.
6. Gribble,C, & Read, H. H.,(1986) Rutley's Elements of Mineralogy. CBS, New Delhi.
7. Perkins,D.(2002). Mineralogy. Prentice Hall, India.
8. Perkins,D. (2005). Mineral Thin Sections. Pearson Education, India.

Web resources: The student can approach the Teacher concerned for relevant and recommended web resources including Inflibnet and NLIST resources available in the Department.

Additional Resources: Soft copies related study materials are available in the Department for access with proper permission from the Teacher concerned.

A**ssignments:** Any two assignments (within the five units) may be suggested by the Teacher.

Suggested Group Work/Tasks: Supervised field visits are suggested with the submission of a field report.

S. No.	COURSE & LEARNING OUTCOMES	
CO1	The student in introduced to the topics in advanced crystallography. The use and application of the stereographic projection. Relevant topics related to x ray mineralogy is also discussed.	Remember, understand, apply, and assess.
CO2	The student is able to describe the different megascopic characteristics of mineral groups and understand their diagnostic properties for nomenclature and identification purposes. The physical properties of minerals are also discussed along with their paragenesis.	Understand, apply, and assess.
CO3	The student is able to describe the different megascopic characteristics of mineral groups and understand their diagnostic properties for nomenclature and identification purposes. The physical properties of minerals are also discussed along with their paragenesis.	Understand, apply, and assess.
CO4	The student is introduced to isotropic and uniaxial mineral optics in detail for application to mineral microscopy.	Understand, apply, and assess.
CO5	The student is introduced to biaxial mineral optics in detail for application to mineral microscopy.	Understand, apply, and assess.

MAPPING WITH PROGRAM OUTCOMES (S – Strong; M- Medium; L-Low)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	S	M	M	S	S
CO2	S	S	M	M	M	S	M	M	S	S
CO3	S	S	M	M	M	S	M	M	S	S
CO4	S	S	M	M	M	S	M	M	S	S
CO5	S	S	M	M	M	S	M	M	S	S

Course Code	Paper Title	Lectures	Tutorials	Practical	Credits
21PGL02	APPLIED GEOMORPHOLOGY	4	1	-	5

Broad Objectives & Teaching Methodology:

Geomorphology is the study of all landforms on the earth's surface including those observed on the ocean floor. It encompasses all surficial geological processes which have sculpted the landforms on earth's surface after the emergence of the atmosphere and hydrological cycle from the geological past.

Geomorphology involves the identification of different landforms, associated processes related to their origin and development, evolution of landforms in terms of geological time, and others. It also includes the ways and means on how geomorphology is useful in the construction of different engineering structures, watershed management, mineral exploration, and others.

The teaching methodology is done by class room lectures, use of physical models, multi media resources, interactive sessions, student involvement sessions with practical and laboratory demonstrations, field visits, microscopic techniques and others.

UNIT I

Basic principles of Geomorphology: Classification of landforms - Geomorphic cycle - Davis and Penck's concept. **Denudational Geomorphology:** Scope of denudational geomorphology- Process of weathering - Types of landforms - Resources, Hazards and Environmental appraisals and Management in Denudational Geomorphic Systems.

UNIT II

Tectonic Geomorphology: Scope of Tectonic Geomorphology - Types of Landforms - Their origin - Resources, Hazards and Environmental Appraisals and Management in Tectono - Geomorphic Systems. **Volcanic Geomorphology:** Scope of Volcanic Geomorphology - Origin of Volcanoes - Spatial Distribution of Volcanoes around the World – Different Volcanic Landforms - Resources, Hazards and Environmental Appraisals and Management of Volcanic Systems.

UNIT III

Coastal Geomorphology: Scope of Coastal Geomorphology - Coastal Zone Processes - Classification of Shorelines, - Constructional and Destructional Landforms (Emerging, Submerging, Neutral and Compound).Coasts: -Coastal Landforms - Resources, Hazards and Environmental Appraisals and Management of Coastal Systems. **Aeolian Geomorphology:** Scope of Aeolian Geomorphology - Processes in Arid Region - Landform Types and Morphology, Aeolian Land Forms - Resources, Hazards and Environmental Appraisals and Management of Aeolian Systems.

UNIT IV

Fluvial Geomorphology: Streams: definition, scope, drainage classification, morphology and types. Life cycle of river systems – youthful, mature and old stages; migratory behaviour of rivers. **Fluvial landforms**: - constructional and destructional landforms; Resources, hazards and environmental appraisals and management in fluvial systems. **Ground water generated landforms**: scope – landform types. **Biogenic landforms**: scope – landform types. **Glacial geomorphology**: scope – landform types – rocks & landforms: Characteristics of rocks and its influence in the evolution of landforms.

UNIT V

Meteorite craters: definition, formation on earth's surface, outline of geological evidences of impact. Basic differences between volcanic and meteorite craters. Geological and geophysical features of impact sites. Outline of Indian meteorites and impact craters. Meteorite craters and mineral deposits. Outline of meteorite falls in Tamil Nadu. Outline of Geomorphic features of the Indian subcontinent**.** Geomorphology of Tamil Nadu – classification, relief features, geological significance, outline of rivers of Tamil Nadu.

REFERENCE & TEXTBOOKS

1. Thornbury,W.D.(1985).Principles of Geomorphology. Wiley. New Delhi.
2. Jha. V.C.(2001).Geomorphology and Remote Sensing, ACB Publications. Delhi
3. Verstappen,H. (1977). Remote Sensing in Geomorphology. Elsevier. Amsterdam.
4. Bloom,A.(2005).Geomorphology. Pearson. Delhi.
5. Spark,A.S. (1976). Geomorphology. ELBS. London.
6. Monkhouse,J. (1987). Geomorphology. Blackie & Sons.
7. Doehring,L. (1980).Geomorphology in Arid Regions, Allen and Unwin, London.
9. Verstappen, H.(1984). Applied Geomorphology, Elsevier, Amsterdam.
10. Hart,A. (1985). Applied Geomorphology. CBS. New Delhi.
11. Goudie, A. (1990). Encyclopedia of Geomorphology. Van Nostrand Reinhold. New York.
12. Goudie, A. (1990). Geomorphological Techniques. Routledge. New Delhi.
13. Singh, S. (2007) Geomorphology. S. Chand & Co. New Delhi.
14. French, B. (1998).Traces of Catastrophe. Lunar & Planetary Institute. Houston.
15. Wasson, J.T. (1974). Meteorites: Classification & Properties. Springer. Berlin.
16. Greeley, R. (1994). Planetary Landscapes. Chapman & Hall. New Delhi.

Web resources: The student can approach the Teacher concerned for relevant and recommended web resources including Inflibnet and NLIST resources available in the Department.

Additional Resources: Soft copies related study materials are available in the Department for access with proper permission from the Teacher concerned.

A**ssignments:** Any two assignments (within the five units) may be suggested by the Teacher.

Suggested Group Work/Tasks: Supervised field visits are suggested with the submission of a field report.

S. No.	COURSE & LEARNING OUTCOMES	
CO1	The student is introduced to landforms, geomorphic cycle, and concepts in	Remember,

	geomorphology. Weathering and related aspects of denudational geomorphology are discussed in detail.	understand, apply, and assess.
CO2	The student is introduced to tectonic and volcanic geomorphology with a detailed discussion of processes, landforms, resources, hazards and others.	Understand, apply, and assess.
CO3	The student is introduced to coastal and aeolian geomorphology with a detailed discussion of processes, landforms, resources, hazards and others.	Understand, apply, and assess.
CO4	The student is introduced to fluvial and glacial geomorphology with a detailed discussion of processes, landforms, resources, hazards and others.	Understand, apply, and assess.
CO5	An outline of geomorphic features of the Indian subcontinent and Tamil Nadu are discussed. Meteorite craters are discussed in detailed as a geomorphic feature.	Understand, apply, and assess.

MAPPING WITH PROGRAM OUTCOMES (S – Strong; M- Medium; L-Low)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	M	S	S	M	S	S
CO2	S	M	S	S	M	S	S	M	S	S
CO3	S	M	S	S	M	S	S	M	S	S
CO4	S	M	S	S	M	S	S	M	S	S
CO5	S	M	S	S	M	S	S	M	S	S

Course Code	Paper Title	Lectures	Tutorials	Practical	Credits
21PGL03	STRATIGRAPHY & PALEONTOLOGY	4	1	5	5

Broad Objectives & Teaching Methodology:

Stratigraphy constitutes the foundation for all geological formations exposed on the earth's crust and explorable subsurface. The geology of any area after mapping, is defined by its stratigraphy and its position in the geological time scale. Stratigraphy draws on petrology, field geology, geological mapping, and others to establish and understand the limited geological history of the area being mapped for geological structures, relative ages of layered rocks, mineral exploration, mining geology, and others. Stratigraphy is also essential for understanding other courses in Applied Geology such as tectonics, sedimentology, paleontology, paleo-ecology, fuel geology, and evolution of extinct fossil groups.

Paleontology is the study of ancient and extinct organisms preserved in appropriate sedimentary rocks. The remains of organisms preserved in sedimentary rock are termed as fossils. Paleontology involves the identification, age determination, evolutionary characteristics, and stratigraphic significance of fossils. It also extends to the estimation and determination of paleo-climates, as fossil indicators in coal and petroleum exploration, and is intimately related to stratigraphy of evident life of Phanerozoic Eon of the geological time scale. The teaching methodology is done by class room lectures, use of physical models, multi media resources, interactive sessions, student involvement sessions with practical and laboratory demonstrations, field visits, microscopic techniques and others.

STRATIGRAPHY

UNIT I

Detailed study of lithostratigraphy, chronostratigraphy, biostratigraphy and their inter relations. Descriptive study of the methods to determine the top and bottom of beds in a stratigraphic sequence. Correlation methods in Stratigraphy: physical, palaeontological, and others. Magneto-stratigraphy: definition, types of polarity, magnetic record in rocks: remanent magnetism and Curie point, magnetic stripes in divergent plate settings, magnetic polarity time scale, correlation of magnetic polarities.

UNIT II

Sequence stratigraphy: definition, components, sedimentation, role of unconformable surfaces, depositional systems, and models in clastic and carbonate depositional environments. Detailed study of the following: Archaean formations of India; Proterozoic formations of Indian Peninsula and their mineral riches; Gondwana Group of India; Triassic and Jurassic.

UNIT III

Detailed study of the following: Cretaceous, and Siwalik formations in India. Age problems in Indian Stratigraphy: 1. Saline Series. 2. Deccan Traps. Stratigraphic boundary problems of India: 1. Precambrian – Cambrian; 2. Permian – Triassic; 3. Cretaceous – Tertiary; Outline of Pleistocene ice ages in India. Detailed description of the Indian Stratigraphical Scale. Subsurface stratigraphy: borehole core logging methods and their applications.

PALEONTOLOGY

UNIT IV

Recent theories on the origin and evolution of life and their fossil evidences. Evolutionary trends and stratigraphic importance of the following invertebrate fossil groups: Trilobites, Cephalopods, Brachiopods and Graptolites. Micropaleontology: Field and laboratory techniques of micropaleontology. Detailed outline of evolution of Foraminifera and Ostracoda.

UNIT V

Taphonomy: definition, principles, applications and limitations. Vertebrate Paleontology and Paleobotany**:** Origin of vertebrates. Evolutionary history of Man and Horse. Short account of Indian dinosaurs and their localities. Study of important Gondwana flora of India. Applications of Paleobotany with reference to Paleoclimate, Oil and Coal exploration. Paleopalynology: A brief study of spores and pollen grains and a short note on their geological record.

REFERENCE & TEXTBOOKS

1.Weller. A.K. (1988). Principles of Stratigraphy. Asia Publishing House. Delhi.

2. Boggs, S. (1987). Principles of Sedimentology and Stratigraphy, Merill Pub. Co. New York.

3. Miall, A.D. (2016). Stratigraphy: A Modern Synthesis. Springer. Delhi.

4. Nichols, G. (2009). Sedimentology & Stratigraphy. Wiley Blackwell. New Delhi.

5. Shrock, R.R. (1948). Sequence in Layered Rocks. McGraw Hill. Delhi.

6. Krishnan. M.S. (1989). Geology of India & Burma. CBS. Delhi.

7. Ramakrishnan, M. & R.Vaidyanathan. (2008). Geology of India. Geol. Soc. Ind. Bangalore.

8. Ravindrakumar, S.(2008). Historical Geology and Stratigraphy of India. EWP. Delhi.

9. Richard, C. (2000). History of Life. Wiley. New Delhi.

10. Black, R.M. (1972). Elements of Paleontology. OUP. Oxford. UK.

11. Clarkson, E.N.K. (2005). Invertebrate Paleontology and Evolution. Wiley. New Delhi.

12. Milsom, C & S.Rigby. (2010). Fossils at a Glance. Wiley Blackwell. New Delhi.

13. Ray,A.K. (2008). Fossils in Earth Sciences. PHI. India. New Delhi.

14. Moore, R.C. et al. (1952). Invertebrate Fossils. CBS. Delhi.

15. Stewart, W.N. & G.W.Rothwell. (2005). Paleobotany. CUP. Delhi.

16. Benton, M.J. (1995). Vertebrate Paleontology. Wiley. New Delhi.

17. Colbert, E.H. et al. (2002). Evolution of the Vertebrates. Wiley. New Delhi.

18. Ray, A.K. (2008). Fossils in Earth Sciences. PHI. New Delhi.

19. Agashe, S.N. (1995). Paleobotany. Oxford & IBH. Delhi.

20. Sahni, A. (2001). Dinosaurs of India. NBT. Delhi.

Web resources: The student can approach the Teacher concerned for relevant and recommended web resources including Inflibnet and NLIST resources available in the Department.

Additional Resources: Soft copies related study materials are available in the Department for access with proper permission from the Teacher concerned.

A**ssignments:** Any two assignments (within the five units) may be suggested by the Teacher.

Suggested Group Work/Tasks: Supervised field visits are suggested with the submission of a field report.

S. No.	COURSE & LEARNING OUTCOMES	
CO1	The student is introduced to the detailed study and applications of lithostratigraphy, chronostratigraphy, and biostratigraphy. Discussion of the methods to determine way up criteria in a stratigraphic sequence; stratigraphic correlation; and magneto-stratigraphy are discussed.	Remember, understand, apply, and assess.
CO2	The student is introduced to a detailed discussion and field applications of sequence stratigraphy. Detailed study and discussion of the following geological formations: Archaean, Proterozoic, Gondwana, Triassic and Jurassic.	Understand, apply, and assess.
CO3	The student is introduced to a detailed study of the following: Cretaceous and Siwalik formations. Detailed discussion of different age problems in Indian Stratigraphy, pleistocene ice ages, and Indian Stratigraphical Scale. Detailed study, discussion and field applications of subsurface stratigraphy.	Understand, apply, and assess.
CO4	The student is introduced to a detailed study of the recent theories on the origin and evolution of life; Descriptive study of the evolutionary trends and stratigraphic importance of trilobites, cephalopods, brachiopods and graptolites. Detailed outline of evolution of Foraminifera and Ostracoda along with field methods in micropaleontology.	Understand, apply, and assess.
CO5	The student is introduced to a detailed study and application of taphonomy; vertebrate origins; evolutionary history of man and horse; Indian dinosaurs localities; important Gondwana flora; varied applications of paleobotany and paleopalynology.	Understand, apply, and assess.

MAPPING WITH PROGRAM OUTCOMES (S – Strong; M- Medium; L-Low)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	S	M	S	S	M	S	S
CO2	S	M	M	S	M	S	S	M	S	S
CO3	S	M	M	S	M	S	S	M	S	S
CO4	S	M	M	S	M	S	S	M	S	S
CO5	S	M	M	S	M	S	S	M	S	S

Course Code	Paper Title	Lectures	Tutorials	Practical	Credits
21PGL04	STRUCTURAL GEOLOGY & GEOTECTONICS	4	1	5	5

Broad Objectives & Teaching Methodology:

Structural Geology is the study of the different structures (of varying scales) in crustal rocks derived from different forces active on and within the earth's crust. It also includes their identification and recognition in the field, applicable mapping techniques, relative age, origin, associated mineral deposits, tectonic relations, and others. Structural geology is intimately associated with plate tectonics paradigm. The teaching methodology is executed via class room lectures, use of physical models, pictures, multi media resources, interactive sessions, student involvement sessions with practical and laboratory demonstrations, field visits and others.

UNIT I

Strain in rock deformation – strain ellipse, finite and incremental strain; Strain in three dimensions: strain ellipsoid, strain ellipsoids based on 'e' values and Flinn's diagram. Strain rate, elastic, ductile and brittle deformation, deformation mechanisms. Application of the strain ellipse in structural geology: shear fractures, stylolites and pressure solution. Foliation: cleavage, foliation, schistosity, axial planar cleavage, crenulation cleavage, relation between bedding and cleavage. Relation between the foliation and the strain ellipsoid. Definition and description of plunge and trend for linear structures. Representation of lines on the stereograms: lineation: slickensides, mineral lineation, intersection lineation, boudinage and folding. Relation between the lineation and the strain ellipsoid.

UNIT II

Folds I: Fold geometry – fold limbs, hinge, inflexion points, fold hinge and fold axis, fold axial plane, monocline, vertical and neutral folds, anticline-antiform, syncline-synform; facing direction of folds; cylindrical folds; depressions and culminations, domes and saddles, profile of a fold; fold tightness. Folds II: Polyharmonic folding; parasitic folds, S, Z and M-folds, chevron and kink folds; conjugate folds; box folds, parallel and similar folds; symmetrical and asymmetrical folds, fold vergence, sheath folds. Faults I. Normal faults, representation of normal faults on the block diagram; Faults II. Listric faults, reverse faults and thrusts. Stratigraphic differences between normal and reverse faults.

UNIT III

Faults III & Joints. Strike-slip faults and their minor structures; joints and rose diagrams, fault rocks: cataclasites and mylonites; introduction to stress, principles of stress, Anderson's theory of faulting. Shear zones: ductile and brittle, recognition of shear zones and faults in field, mechanics of shearing and faulting. Porphyroclasts - mica fish - quartz ribbons. Petrofabric analysis: data collection, plotting, symmetry and interpretation, concept of symmetry of fabric of tectonites.

UNIT IV

Geotectonics: Introduction-tectonic framework of earth's crust- Isostasy, convection currents. Continental Drift: evidences in support of continental drift and in-situ theories. Sea-floor spreading: Hess's concept and evidences of sea-floor spreading. Plate tectonics: Concept of crustal

plate and plate movements- plate model of Morgan, nature of convergent, divergent and conservative plate margins- transpression and transtension. Concept of neotectonism-evidences.

UNIT V

Plate tectonics and economic mineralization. Triple junctions- aulocogens- plume theory-rift valleys-island arcs. Wilson Cycle and plate tectonics. Tectonic mélanges. Geometry of thrust sheets: block faulted and rifted regions. Nappe, klippe and tectonic window, flat and steeps of the reverse faults, autochthonous and allochthonous units, imbricate and duplex structures, horse. Heat flow in the Earth: concept of continental and oceanic geotherm. Outline of supercontinents in earth history: Ur-Rodinia-Pangea-Gondwana. Outline of the tectonic framework of İndia.

REFERENCE & TEXTBOOKS

1.Ramsay, J.G. & M.I.Huber.(1983).The Techniques of Modern Structural Geology, 3 Vols. Academic Press, London.

2.Davis, G.H., & S.J.Reynolds.(1996). Structural Geology of Rocks and Regions, Wiley. Delhi.

4.Park, P.G.(1983).Foundations of Structural Geology, Blackie. London.

5.Price, N.J. and J.W.Cosgrove.(1990). Analysis of Geological Structures. Chapman & Hall. UK.

6.Bayly, B.(1992). Mechanics in Structural Geology. Springer. Delhi.

7.Moore,E. and R.J.Twiss. (1995). Tectonics. Freeman. New York.

8. Keary,P and F.J.Vine. (1990); - Global Tectonics. Cambridge University Press. Delhi.

9. Santhosh,M & J.J.W.Rogers. (2010). Continents and Supercontinents. OUP.Delhi.

10. Ghosh, S.K. (1993). Structural Geology. Elsevier. Delhi.

11. Lowrie,W. (2007). Fundamentals of Geophysics. 2nd ed. CUP. Delhi.

12. Mussett,A.E. & Khan,M.A. (2000). Looking into the Earth. CUP. Delhi.

13. Ragan, D.M. (2000). Structural Geology. 2nded.Wiley. New York.

14. Lisle, R.J & Peter R Leyshon. (2004). Stereographic Projection Techniques for Geologists and Civil Engineers. CUP. Delhi.

15. Fossen, H. (2010). Structural Geology. Cambridge University Press. New Delhi.

16. Sathya Narayanaswami, B.S. (1994). Structural Geology. Dhanpat Rai & Sons. New Delhi.

17. Gokhale, N.W. (1995), Theory of Structural Geology, CBS, Delhi.

Web resources: The student can approach the Teacher concerned for relevant and recommended web resources including Inflibnet and NLIST resources available in the Department.

Additional Resources: Soft copies related study materials are available in the Department for access with proper permission from the Teacher concerned.

A**ssignments:** Any two assignments (within the five units) may be suggested by the Teacher.

Suggested Group Work/Tasks: Supervised field visits are suggested with the submission of a field report.

S. No.	COURSE & LEARNING OUTCOMES	
CO1	The student is introduced to a detailed discussion, identification, experimental procedures, and application of strain in rock deformation; foliation, linear structures, and to the representation of lines on the stereograms.	Remember, understand, apply, and assess.
CO2	The student is introduced to a detailed study, discussion, identification, experimental procedures, and genesis of folds and faults.	Understand, apply, and assess.
CO3	The student is introduced to a detailed study, discussion, identification, experimental procedures, recognition, and genesis of strike slip faults, joints, shear zones, petrofabric analysis and tectonites.	Understand, apply, and assess.
CO4	The student is introduced to a detailed study and discussion of geotectonics, tectonic framework of earth's crust, isostasy, convection currents, continental drift, and sea-floor spreading. The student is introduced to a detailed study and discussion of plate tectonics and neotectonism.	Understand, apply, and assess.
CO5	The student is introduced to advanced topics in plate tectonics, Wilson cycle, tectonic mélanges, thrust sheets, heat flow in the Earth, continental and oceanic geotherm, supercontinents in earth history, and tectonic framework of İndia.	Understand, apply, and assess.

MAPPING WITH PROGRAM OUTCOMES (S – Strong; M- Medium; L-Low)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	M	S	S	M	S	S
CO2	S	S	S	S	M	S	S	M	S	S
CO3	S	S	S	S	M	S	S	M	S	S
CO4	S	S	S	S	M	S	S	M	S	S
CO5	S	S	S	S	M	S	S	M	S	S

Course Code	Paper Title	Lectures	Tutorials	Practical	Credits
21PGL05	ECONOMIC GEOLOGY & MINERAL ECONOMICS	4	1	-	5

Broad Objectives & Teaching Methodology:

Economic Geology is the study of mineral deposits. It is closely allied to mining and exploration geology. It is concerned with the 4origin and genesis, mode of occurrence, mineralogy, petrographic characters, host rock association, and tectonic association of mineral deposits. The student is introduced to the advanced topics related to deposit generating processes, and applications of economic geology. Mineral economics is the application of basic economic principles, laws, and regulations related to the exploration, extraction, mining, environmental aspects, and others. This course supports exploration and mining geology. The teaching methodology is done by class room lectures, use of physical models, multi media resources, interactive sessions, student involvement sessions with practical and laboratory demonstrations, field visits, microscopic techniques and others.

UNIT I

Controls of ore deposit localization, physico-chemical controls of ore deposition and post depositional changes in ores. Morphological characters of ore deposits. Crustal evolution and metallogeny of the Indian shield. Distribution of ore deposits with reference to plate tectonics settings. Outline of classification of ore deposits.

UNIT II

Magmatic deposits: Chromite deposits; Nickel sulphide deposits; Kimberlite diamond deposits. Magmatic Hydrothermal deposits: Porphyry base metal deposits – Volcanogenic Massive Sulphide deposits. Hydrothermal Vein deposits: Definition – Classification of vein deposits – Hydrothermal gold deposits.

UNIT III

Sediment hosted Cu-Pb-Zn deposits: Sedimentary exhalative deposits – Mississippi Valley type deposits. Ores deposits generated by weathering: bauxite, laterite, kaolin, manganese and supergene base metal sulphides. Stratifrom & stratabound deposits.

UNIT IV

Ore deposits generated by metamorphism: Skarns – definition, classification, and genesis. Placer deposits: Definition – Classification – Beach sand, Marine, and Placer deposits. Greisen deposits.

UNIT V

Mineral economics: - Significance of minerals in national economy-demand and supplies-substitutes-market economy-critical – essential and strategic minerals - mineral conservation policy-India's status in mineral production. Ore Microscopy:- Polishing and mounting of ores, textures and structures of ore minerals, applications of ore microscopy. Geological thermometry and barometry as applied to ore minerals. Role of fluid inclusions in ore depositional environments

REFERENCE & TEXT BOOKS:

1. Evans, A.M. (1993). Ore Geology & Industrial Minerals. Blackwell Science. Wiley. Delhi.
2. Pohl.W.L, (2011). Economic Geology. Wiley. Delhi.
3. Ridley,J. (2013). Ore Deposit Geology. CUP. Delhi.
4. Mishra, K.C. (2000). Understanding Mineral Deposits. Springer. Delhi.
5.Edwards, R & K. Atkinson. (1986). Ore Deposit Geology, Chapman & Hall, London.
6.Bateman, A.M & M.L.Jensen (1981). Economic mineral Deposits, John Wiley, New York.
7.Craig, R.C & D.V.Vaughan. (1985).Ore Microscopy and Ore Petrography. Wiley, New York.
8. Lindgren, W. (1942), Mineral Deposits, McGraw Hill. New York.
9.Park, C.F. & M.A.MacDiarmid (1970).Ore Deposits. William Freeman, New York.
10.Stanton, R.L. (1972), Ore petrology, McGraw Hill. New York.
11.Sharma, N.L. & R.K. Sinha. (1985). Mineral Economics. Oxford & IBH. Delhi.
12. Robb,L.(2005). Introduction to Ore forming Processes. Wiley. Delhi.
13. Deb,M & S.C.Sarkar. (2017). Minerals & Allied Natural Resources. Springer. Delhi.

Web resources: The student can approach the Teacher concerned for relevant and recommended web resources including Inflibnet and NLIST resources available in the Department.

Additional Resources: Soft copies related study materials are available in the Department for access with proper permission from the Teacher concerned.

A**ssignments:** Any two assignments (within the five units) may be suggested by the Teacher.

Suggested Group Work/Tasks: Supervised field visits are suggested with the submission of a field report.

S. No.	COURSE & LEARNING OUTCOMES	
CO1	The student is introduced to the detailed study, discussions, recognition, and applications of ore deposit localization, morphological characters of ore deposits, crustal evolution and metallogeny, ore deposits and plate tectonics settings, and modern classification schemes of ore deposits.	Remember, understand, apply, and assess.
CO2	The student is introduced to a detailed study, discussion, identification, recognition, and field applications of magmatic deposits, magmatic hydrothermal deposits, and hydrothermal vein deposits.	Understand, apply, and assess.
CO3	The student is introduced to a detailed study discussion, identification, recognition, and field applications of sediment hosted Cu-Pb-Zn deposits, sedimentary exhalative deposits, ore deposits related to weathering, and stratifrom & stratabound deposits.	Understand, apply, and assess.
CO4	The student is introduced to a detailed study, discussion, identification, recognition, and field applications of ore skarns, placer deposits, and greisen deposits.	Understand, apply, and assess.
CO5	The student is introduced to a detailed study and discussion of mineral economics, ore microscopy, geological thermometry and barometry, and to the role of fluid inclusions in assessing ore depositional environments.	Understand, apply, and assess.

MAPPING WITH PROGRAM OUTCOMES (S – Strong; M- Medium; L-Low)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	M	S	S	M	S	S
CO2	S	S	S	S	M	S	S	M	S	S
CO3	S	S	S	S	M	S	S	M	S	S
CO4	S	S	S	S	M	S	S	M	S	S
CO5	S	S	S	S	M	S	S	M	S	S

Course Code	Paper Title	Lectures	Tutorials	Practical	Credits
21PGL06	EXPLORATION GEOPHYSICS	4	1	-	5

Broad Objectives & Teaching Methodology:

Exploration Geophysics deals with the principles, methods and instrumentation of basic geophysics applied to mineral exploration. Exploration geophysics is related to exploration geology, mining geology, petroleum geology, engineering geology, and other courses where exploration geophysical instruments and equipment are being used as in geoarchaeology. The teaching methodology is executed via class room lectures, use of physical models, pictures, multi media resources, interactive sessions, student involvement sessions with practical and laboratory demonstrations, field visits and others.

UNIT I

Outline of geophysical data processing. **Gravity Method:** Newton's Law of Gravitation. Gravity measurements: Absolute and relative. Gravity units. Gravimeters: Stable and Unstable gravimeters – calibration. Corrections to raw gravity data. Gravity Surveys – gravity contour maps – gravity anomalies – separation of regional and residual gravity anomalies. Gravity profiles and half width anomalies. Interpretation of gravity anomalies using model shapes and masses. Brief outline of mineral and rock densities. Applications and limitations of gravity methods.

UNIT II

Magnetic Methods: Components of earth's magnetic field. Magnetic character of rocks and minerals. Units of measurement. Magnetometers: Types and Survey procedures. Raw magnetic data and their corrections Preparation of magnetic contour maps – magnetic anomalies – separation of regional and residual magnetic anomalies – magnetic profiles and half width anomalies. Interpretation of magnetic anomalies using model shapes and masses. Applications and limitations of magnetic methods.

UNIT III

Electromagnetic Methods: Principle of EM method – depth penetration. Field Instruments for EM surveys. Frequency domain methods – Time domain methods – Units of measurement – Interpretation of EM data – Application and limitations. Brief outline of telluric and magneto telluric fields**.** Brief outline of GPR and its applications**. Electrical Methods:** Ohm's Law – Resistivity and conductivity – Electrical properties of rocks and minerals – Units of measurement **-** Apparent resistivity – Resistivity surveying equipment – Sounding and profiling methods – Electrode configurations: Wenner – Schlumberger – Gradient – Pole – Dipole and Dipole – dipole methods. Interpretation of resistivity data. Applications and limitations of resistivity methods.

UNIT IV

Self Potential Methods: Definition – origin and types – surveys – data reduction and interpretation. **Induced Polarization Method**: Definition – origin and types – surveys – data reduction and interpretation. **Seismic methods:** General principles – refraction and reflection of seismic waves. Elastic properties of rocks. Methods of generating artificial seismic waves. Geophones – types and their limitations. Recording equipment. **Refraction Methods:** Principle – Instruments and equipment – Field Methods: Fan, Arc, and Profile shooting. Data reduction and corrections. Interpretation methodology for vertical layers – horizontal layers: two and three layers – dipping layers.

UNIT V

Seismic Reflection Methods: Principle – Instruments and equipment – Field Operations: Shot point and Detector spreads: Split spread shooting – Common depth point spread. Data processing and corrections. Interpretation methodology for reflecting layers: single and multiple reflectors – dipping reflectors - faulted reflectors. **Geophysical Well Logging of Bore holes:** Bore hole environment – Logging equipment – Types of Logging: Electrical (resistivity, induction) – Radiometric (γ – ray, neutron – γ ray) – Sonic – Magnetic – Temperature – Caliper – Gravity – Cement. Applications and limitations of the different logging methods.

REFERENCE BOOKS & TEXT BOOKS

1. Ramachandra Rao, M.B. (1975). Outlines of Geophysical Prospecting. EBD. Dhanbad. (reprint).

2. Kearey, P. & Others. (2002). An Introduction to Geophysical Exploration. Wiley. Delhi.

3.Mussett,A.E. & Khan,M.A. (2000). Looking into the Earth. CUP. New Delhi.

4.Lowrie,W. (2020). Fundamentals of Geophysics. 3rd edition., CUP. New Delhi.

5.Sharma,P.V. (1997). Environmental and Engineering Geophysics. CUP. Delhi.

6.Telford,W.M; Geldart,L.P & Sheriff,R.E. (1990). Applied Geophysics. CUP. Delhi.

7.Dobrin,M.B. (1988). Introduction to Geophysical Prospecting. McGraw Hill. Delhi. .

8.Parasnis,D.S. (1975). Principles of Applied Geophysics. Chapman & Hall. New York.

9. Banerjee,P.K. (1997). Elements of Prospecting for Non Fuel Mineral Deposits. AP. Chennai.

10. Robinson, E.S & Coruh.C. (1988). Basic Exploration Geophysics. Wiley.Delhi.

11.Moon,C.J; & Others. (2006). Introduction to Mineral Exploration. Wiley. Delhi.

13. Milsom,J (2011). Field Geophysics. Wiley. Delhi.

14. Ellis, D.V. & Singer.J.M. (2008). Well logging for Earth Scientists. Springer .Delhi.

15. Asquith,G. (1982). Basic Well Log Analysis for Geologists. AAPG. Oklahoma.

Web resources: The student can approach the Teacher concerned for relevant and recommended web resources including Inflibnet and NLIST resources available in the Department.

Additional Resources: Soft copies related study materials are available in the Department for access with proper permission from the Teacher concerned.

A**ssignments:** Any two assignments (within the five units) may be suggested by the Teacher.

Suggested Group Work/Tasks: Supervised field visits are suggested with the submission of a field report.

S. No.	COURSE & LEARNING OUTCOMES	
CO1	The student is introduced to a detailed discussion on the basic theory, principles,	Remember,

	instruments, field procedures, interpretation of field data, modelling of anomalies, and application of the gravity methods of geophysical prospecting.	understand, apply, and assess.
CO2	The student is introduced to a detailed discussion on the basic theory, principles, instruments, field procedures, interpretation of field data, modelling of anomalies, and application of the magnetic methods of geophysical prospecting.	Understand, apply, and assess.
CO3	The student is introduced to a detailed discussion on the basic theory, principles, instruments, field procedures, interpretation of field data, modelling of anomalies, and application of the electromagnetic, GPR, and electrical methods of geophysical prospecting.	Understand, apply, and assess.
CO4	The student is introduced to a detailed discussion on the basic theory, principles, instruments, field procedures, interpretation of field data, modelling of anomalies, and application of the self potential, induced polarization, and seismic reflection methods of geophysical prospecting.	Understand, apply, and assess.
CO5	The student is introduced to a detailed discussion on the basic theory, principles, instruments, field procedures, interpretation of field data, modelling of anomalies, and application of the seismic refraction and well logging methods of geophysical prospecting.	Understand, apply, and assess.

MAPPING WITH PROGRAM OUTCOMES (S – Strong; M- Medium; L-Low)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	S	S	S	M	S	S	S
CO2	S	M	M	S	S	S	M	S	S	S
CO3	S	M	M	S	S	S	M	S	S	S
CO4	S	M	M	S	S	S	M	S	S	S
CO5	S	M	M	S	S	S	M	S	S	S

Course Code	Paper Title	Lectures	Tutorials	Practical	Credits
21PGL07	IGNEOUS & METAMORPHIC PETROLOGY	4	1	5	5

Broad Objectives & Teaching Methodology:

Petrology is the foundation for structural geology, economic geology, field geology, mining geology, exploration geology, other courses where rock identification and petrography is essential and necessary. The proper identification of rocks in the laboratory or in the field, is a precursor to assess their mode of occurrence, association, expected economic mineralization, and others. Igneous rocks are the products of magma or lava consolidation. It also extends to asteroids, meteorites, lunar rocks, and related extraterrestrial materials. Metamorphic rocks are the products of pre-existing rocks which have experienced varying conditions of pressure and temperature within the earth's crust, with little or minimal alteration by chemically active fluids. The teaching methodology is done by class room lectures, use of physical models, multi media resources, interactive sessions, student involvement sessions with practical and laboratory demonstrations, supervised field visits, microscopic techniques and others.

IGNEOUS PETROLOGY

UNIT I

Magma properties: viscosity – Bingham and Newtonian liquids as applied to magmas; temperature; density; pressure and volatile content. Generation of magma: causes of melting; tectonic environments of melting in the lithosphere. Application of phase rule in igneous petrology and petrological significance of the following synthetic magma systems: Albite – Orthoclase system; Leucite – Silica system; Diopside – Anorthite – Forsterite system; Quartz – Nepheline – Kalsilite system; Outline of Quaternary System for Basalt. Short account of mantle plumes, magma plumbing, and large igneous provinces.

UNIT II

Classification of Igneous rocks: IUGS scheme for plutonic and volcanic rocks; IUGS scheme for fragmental volcanic rocks; TAS scheme; Magmatic differentiation: definition and mechanisms. Outline of magma mixing and mingling. Assimilation: definition and processes, evidences and field recognition. Petrography, nomenclature, classification and petrogenesis of the following rocks or rock groups: Basalts; Ophiolites; Alkaline Rocks; Ultramafic Rocks.

UNIT III

Bowen's Reaction Series and its petrological significance. Variation Diagrams in igneous petrology: definition, types and their utility. Short account on the use of trace element and REE abundances in igneous petrogenesis. Petrography, nomenclature, classification and petrogenesis of the following rocks or rock groups: Anorthosites; Lamprophyre; Granite; Pegmatite; Carbonatite; Kimberlite.

METAMORPHIC PETROLOGY

UNIT IV

Classification schemes of metamorphic rocks. Crystalloblastic Series and interpretation of metamorphic rock textures. Outline of different metamorphic reactions. Basic differences between prograde and retrograde metamorphism. Regional metamorphic gradients and their types. Outline of protoliths that undergo metamorphism. Barrovian and Buchan metamorphic zones; isograds. Burial metamorphic zones. Short account of metamorphic geothermometers and geobarometers.

Petrography, nomenclature, classification and genesis of the following rocks or rock groups: Eclogites; Migmatites; Amphibolites.

UNIT V

Distribution of metamorphic rocks with respect to different plate tectonic environments. Paired Metamorphic Belts and its characteristic features. Application of phase rule in metamorphic systems. Metamorphic facies: definition, types, and graphical representation of metamorphic rocks in ACF, AKF, and AKFM diagrams. Outline of Petrogenetic grids. Utility of Pressure – temperature – time paths. Petrography, nomenclature, classification and genesis of the following rocks or rock groups: Granulites: Charnockite. Khondalites; Gondites.

REFERENCE & TEXTBOOKS

1. Winter, J.D.(2010).Principles of Igneous and Metamorphic Petrology. PHI. New Delhi.
2. Haung,W.T. (1962). Petrology. McGraw Hill. New York.
3. Williams,H. et al. (1982). Petrography. CBS. New Delhi.
4. McBirney, A.R. (1993). Igneous Petrology. CBS. New Delhi.
5. Best,M.G. (2005). Igneous Petrology. Wiley. New Delhi.
6. Best,M.G. (2003). Igneous and Metamorphic Petrology. Wiley. New Delhi.
7. Hatch,F.H. et al. Petrology of the Igneous Rocks. CBS. Delhi.
8. Hyndman,D.W. (1985). Petrology of the Igneous and Metamorphic Rocks. McGraw Hill. NY.
9. Middlemost,E.A.K. (1985). Magmas and Magmatic Rocks. Longman. UK.
10. Winkler,H.G.F. (1970). Petrology of the Metamorphic Rocks. Springer. New Delhi.
11. Turner,F.J. (1968). Metamorphic Petrology. McGraw Hill. New York.
12. Bose,M.K. (1997). Igneous Petrology. World Press. Kolkata.
13. K.G.Cox et al. (1979). The Interpretation of Igneous Rocks. Springer. New Delhi.
14. Chatterjee,S.C. (1974). Petrography of the Igneous & Metamorphic Rocks of India. Macmillan. Delhi.
15. Rollinson, H. (1995). Using Geochemical Data. Longman Scientific. UK.

Web resources: The student can approach the Teacher concerned for relevant and recommended web resources including Inflibnet and NLIST resources available in the Department.

Additional Resources: Soft copies related study materials are available in the Department for access with proper permission from the Teacher concerned.

A**ssignments:** Any two assignments (within the five units) may be suggested by the Teacher.

Suggested Group Work/Tasks: Supervised field visits are suggested with the submission of a field report.

S. No.	COURSE & LEARNING OUTCOMES	
CO1	The student is introduced to a detailed discussion on magma properties; generation of magma; tectonic environments of melting in the lithosphere;	Remember, understand,

	application of phase rule in igneous petrology and petrological significance of important synthetic magma systems; along with a short account of mantle plumes, magma plumbing, and large igneous provinces.	apply, and assess.
CO2	The student is introduced to a detailed discussion on the classification of igneous rocks; magmatic differentiation; magma mixing and mingling; magma assimilation; detailed petrology and petrogenesis of: basalts; ophiolites; alkaline rocks; and ultramafic rocks.	Understand, apply, and assess.
CO3	The student is introduced to a detailed discussion on Bowen's Reaction Series and its petrological significance; variation diagrams in igneous petrology; use of trace and REE in petrogenesis; detailed petrology and petrogenesis of anorthosites; lamprophyre; granite; pegmatite; carbonatite; kimberlite.	Understand, apply, and assess.
CO4	The student is introduced to a detailed discussion on the classification schemes of metamorphic rocks; crystalloblastic series and interpretation of metamorphic rock textures; metamorphic reactions; regional metamorphic gradients and their types; protoliths that undergo metamorphism; Barrovian and Buchan metamorphic zones; isograds; burial metamorphic zones; metamorphic geothermometers and geobarometers. detailed petrology and petrogenesis of eclogites; migmatites; amphibolite.	Understand, apply, and assess.
CO5	The student is introduced to a detailed discussion on distribution of metamorphic rocks with plate tectonic environments; paired metamorphic belts; phase rule in metamorphic systems; metamorphic facies; ACF, AKF, and AKFM diagrams; petrogenetic grids; P-T-t paths; detailed petrology and petrogenesis of granulites; charnockite; khondalites; gondites.	Understand, apply, and assess.

MAPPING WITH PROGRAM OUTCOMES (S – Strong; M- Medium; L-Low)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	M	S	M	M	S	S
CO2	S	S	S	M	M	S	M	M	S	S
CO3	S	S	S	M	M	S	M	M	S	S
CO4	S	S	S	M	M	S	M	M	S	S
CO5	S	S	S	M	M	S	M	M	S	S

Course Code	Paper Title	Lectures	Tutorials	Practical	Credits
21PGL08	SEDIMENTARY PETROLOGY & SEDIMENTOLOGY	4	1	5	5

Broad Objectives & Teaching Methodology:

The student is introduced to the basic, applied principles, and applications of sedimentary petrology and sedimentology. Sedimentary petrology is the detailed petrographic study of sedimentary rocks generated on the earth's crust. The proper identification of sedimentary rocks in the laboratory or in the field, is a precursor to assess their mode of occurrence, association, expected economic mineralization, and others. Sedimentology is the branch of geology concerned with the nature and genesis of sediments. It includes all processes related to sediment origin, their dispersal, deposition, and transformation into a sedimentary rock. Sedimentology is closely related to basic stratigraphic principles and laws. The teaching methodology is done by class room lectures, use of physical models, multi media resources, interactive sessions, student involvement sessions with practical and laboratory demonstrations, field visits, microscopic techniques and others.

UNIT I **SEDIMENTARY PETROLOGY**

Sedimentary petrology: definition and scope. Classification of sedimentary rocks. Short account of sedimentary facies and facies models. Petrography, nomenclature, classification, chemical composition, associated depositional environments, and genesis of sandstones, conglomerates, breccias, and mud rocks.

UNIT II

Petrography, nomenclature, classification, chemical composition, associated depositional environments, and genesis of limestones, evaporites, cherts, and siliceous sediments. Petrography, nomenclature, classification, chemical composition, associated depositional environments, and genesis of volcano-clastic sediments.

UNIT III **SEDIMENTOLOGY**

Definition and scope of Sedimentology. Outline of weathering processes and cycle of sedimentation. Generation of sediment by geomorphic agencies and their processes. Lithification & diagenesis of sediments. Grain size determination: field methods of sample collection, preparation of samples, direct measurements, dry and wet sieving.

UNIT IV

Palaeocurrent data: field methods, analysis, and interpretation. Grain size analysis: statistical treatment of data and their graphical representation. Provenance of sedimentary rocks. Heavy minerals: field methods of sampling, separation techniques, identification, and interpretation. Short account of the use of trace fossils in sedimentary rocks.

UNIT V

Analysis of sedimentary rocks: XRF and SEM methods. Role of colloids in sedimentation. Sedimentary basins: definition, types, and tectonic association. Sedimentary depositional environment: non-marine; transitional; and marine. Petrography, nomenclature, classification, chemical composition, associated depositional environments, and genesis of sedimentary iron and phosphates.

REFERENCE & TEXT BOOKS

1. Tyrell,G.W. (1958). Principles of Petrology. B.I. Publications. New Delhi.
2. Haung,W.T. (1962). Petrology. McGraw Hill. New York.
3. Williams,H. et al. (1982). Petrography. CBS. New Delhi.
4. Lindholm, R.C. (1987). A Practical Approach to Sedimentology. CBS. Delhi.
5. Lewis, D.W. & D.McConchie. (1994). Analytical Sedimentology. Springer. Delhi.
6. Tucker, M.E. (1988). Techniques in Sedimentology. Wiley. Delhi.
7. Tucker, M.E. (2001). Sedimentary Petrology. Wiley. Delhi.
8. Tucker, M.E. (2003). Sedimentary rocks in the field. Wiley. Delhi.
9. Greensmith,J.T. (1976). Petrology of the Sedimentary Rocks. CBS. Delhi.
10. Folk,R.L. (1974). Petrology of the Sedimentary Rocks. Hemphill. Texas.
11. Boggs, S. (2006). Principles of Sedimentology & Stratigraphy. PHI. Delhi.
12. Friedman, G.M. & J.E.Sanders. (1978). Principles of Sedimentology. Wiley. Delhi.

Web resources: The student can approach the Teacher concerned for relevant and recommended web resources including Inflibnet and NLIST resources available in the Department.

Additional Resources: Soft copies related study materials are available in the Department for access with proper permission from the Teacher concerned.

A**ssignments:** Any two assignments (within the five units) may be suggested by the Teacher.

Suggested Group Work/Tasks: Supervised field visits are suggested with the submission of a field report.

S. No.	COURSE & LEARNING OUTCOMES	
CO1	The student is introduced to a detailed discussion on the classification of sedimentary rocks; sedimentary facies, facies models and detailed study of sandstones, conglomerates, breccias, and mud rocks.	Remember, understand, apply, and assess.
CO2	The student is introduced to a detailed discussion and study of limestones, evaporites, cherts, siliceous sediments, and volcano-clastic sediments.	Understand, apply, and assess.
CO3	The student is introduced to a detailed discussion on different aspects of sedimentology, including generation of sediment, lithification & diagenesis of sediments, and grain size determination.	Understand, apply, and assess.
CO4	The student is introduced to a detailed discussion on palaeocurrent data; grain size analysis; provenance of sedimentary rocks; heavy minerals; and detailed study of sedimentary iron and phosphates.	Understand, apply, and assess.
CO5	The student is introduced to a detailed discussion on analysis of sedimentary rocks; role of colloids in sedimentation.; sedimentary basins; sedimentary depositional environments; trace fossils in sedimentary rocks;.	Understand, apply, and assess.

MAPPING WITH PROGRAM OUTCOMES (S – Strong; M- Medium; L-Low)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	S	M	M	S	S
CO2	S	S	M	M	M	S	M	M	S	S
CO3	S	S	M	M	M	S	M	M	S	S
CO4	S	S	M	M	M	S	M	M	S	S
CO5	S	S	M	M	M	S	M	M	S	S

Course Code	Paper Title	Lectures	Tutorials	Practical	Credits
21PGL09	HYDROGEOLOGY	4	1	5	5

Broad Objectives & Teaching Methodology:

Hydrogeology is the branch of geology concerned with the geological distribution of surface and groundwater. The student is introduced to the fundamentals and applied aspects of hydrogeology. The teaching methodology is done by class room lectures, use of physical models, multi media resources, interactive sessions, student involvement sessions with practical and laboratory demonstrations, field visits, and others.

UNIT I

Aquifers: types and hydrostratigraphic units. Hydrological properties of rocks: porosity, permeability, specific yield and retention, base flow, transmissivity, and storage coefficient. Ground water flow equations: steady and transient flow. D'Arcy's law: hydraulic conductivity, steady, unsteady and radial flow. Pumping tests: definition, methodology, data collected, and interpretation by Theis, Cooper-Jacob's, and Chow's method.

UNIT II

Outline of water quality standards and guidelines: WHO, BIS and ICAR. Physical parameters of groundwater quality. Analysis of major and minor elements in groundwater using APHA standards. Water quality parameters for drinking, agriculture, and industrial uses. Graphical representation and interpretation of water quality data: Wilcox, USSL, Gibbs plot, Piper, Donean and Durov diagrams.

UNIT III

Groundwater basins: drainage and basin morphometry. Methods of determining groundwater flow and preparation of water table contour maps. Tracer studies relevant to groundwater flow. Problems due to over exploitation of groundwater. Groundwater recharge: natural and artificial methods. Rainwater harvesting: definition, methods and techniques, maintenance, periodic assessment, remedial measures.

UNIT IV

Water shed management: definition, physiographic features of a watershed: geometrical characteristics, surface area, shape, relief and hypsometric curves, drainage network, typology of flow and drainage. Outline of methods of groundwater exploration. Coastal aquifers: Ghyben-Herzberg relation and saline water intrusion.

UNIT V

Water wells: definition, types of water wells; well construction in hard and soft rock terrains; drilling in hard rock and soft rock; Wetlands- Geological significance, classification and mode of formation. Conservation and management of wetlands in India. Groundwater provinces of Tamil Nadu. Groundwater basins in Tamil Nadu.

REFERENCE & TEXTBOOKS

1. Todd, D.K. (2008). Groundwater Hydrology. 5th ed. Wiley. New Delhi.
2. Davis, S.N. & R.J.M. DeWiest. (1966). Hydrogeology. Wiley. Delhi.
3. Freeze, R.A. & J.A.Cherry. (1979).Groundwater. Prentice Hall. New York.
4. Raghunath, H.M. (1988). Groundwater. East West Pub. Delhi.
5. Raghunath, H.M. (1985).Hydrology. East West Pub. Delhi.
6. Fetter, G.W. (1989). Applied Hydrogeology. CBS. Delhi.
7. Ramakrishnan, S. (2011). Ground Water. Scitech Publications. Chennai.
8. Garg, S.P. (1982). Groundwater and Tube Wells. Oxford & IBH. Delhi.
9. Hiscock, K.M.(2005). Hydrogeology. Blackwell Science. Delhi.

Web resources: The student can approach the Teacher concerned for relevant and recommended web resources including Inflibnet and NLIST resources available in the Department.

Additional Resources: Soft copies related study materials are available in the Department for access with proper permission from the Teacher concerned.

A**ssignments:** Any two assignments (within the five units) may be suggested by the Teacher.

Suggested Group Work/Tasks: Supervised field visits are suggested with the submission of a field report.

S. No.	COURSE & LEARNING OUTCOMES	
CO1	The student is introduced to a detailed discussion on aquifers; hydrological properties of rocks; ground water flow equations; D'Arcy's law; pumping tests and their interpretation by Theis, Cooper-Jacob's, and Chow's method.	Remember, understand, apply, and assess.
CO2	The student is introduced to a detailed discussion and study of water quality standards and guidelines; physical parameters of groundwater quality; analysis of major and minor elements in groundwater; water quality parameters; and graphical representation and interpretation of water quality data.	Understand, apply, and assess.
CO3	The student is introduced to a detailed discussion on different aspects of groundwater basins; methods of determining groundwater flow and preparation of water table contour maps; tracer studies relevant to groundwater flow; over exploitation of groundwater; groundwater recharge; and rainwater harvesting.	Understand, apply, and assess.
CO4	The student is introduced to a detailed discussion on water shed management; outline of methods of groundwater exploration; coastal aquifers: Ghyben-Herzberg relation and saline water intrusion.	Understand, apply, and assess.
CO5	The student is introduced to a detailed discussion on water wells; drilling in hard rock and soft rock; wetlands; groundwater provinces of Tamil Nadu; and groundwater basins in Tamil Nadu.	Understand, apply, and assess.

MAPPING WITH PROGRAM OUTCOMES (S – Strong; M- Medium; L-Low)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	S	M	M	S	S	S
CO2	S	M	M	M	S	M	M	S	S	S
CO3	S	M	M	M	S	M	M	S	S	S
CO4	S	M	M	M	S	M	M	S	S	S
CO5	S	M	M	M	S	M	M	S	S	S

Course Code	Paper Title	Lectures	Tutorials	Practical	Credits
21PGL10	MINING GEOLOGY & ORE DRESSING	4	1	5	5

Broad Objectives & Teaching Methodology:

Mining geology is the practical application of geological principles for the viable and cost effective extraction of ores and economic minerals from their host rocks. It is closely related to economic geology, mineral exploration, and ore petrology. The student is introduced to the basic and applied principles of mining geology. The role of a geologist in different stages of quarrying and mining is emphasized in the course. Ore dressing is related to mining geology. The main aim of ore dressing is to enhance the extractable metal content of ore minerals or increase the purity of an industrial mineral after mining. This is done by physically removing the unwanted matrix and gangue materials. Ore dressing is done prior to metal extraction or manufacture of end materials by the factory. The teaching methodology is done by class room lectures, use of physical models, multi media resources, interactive sessions, student involvement sessions with practical and laboratory demonstrations, field visits to working quarries and mines, and others.

UNIT I **MINING GEOLOGY**

Valuation of mining properties. Classification of reserves. Estimation of ore reserves and evaluation of ore bodies for mining. Outline of preparing a mining geology report and proposed plan for mining. Open cast mining methods: Parts of an open cast mine; over burden removal; Open cast mining equipment; Strip mining and surface augering; Hydraulicking methods; Offshore dredging of minerals; Outline of mechanised mining. Groundwater problems in mines.

UNIT II

Mine Operations: Drilling: purpose; methods – rotary, percussive, diamond core drilling; augering; Removal of broken ores and rock: manual and mechanised. Alluvial mining methods; Quarrying methods; Environmental parameters monitored in mines; Subsurface Mining Methods I: Open stopes: gophering; face level, underhand, overhand, mill hole; room and pillar and sublevel stoping;

UNIT III

Subsurface Mining Methods II: Supported stopes: overhand, pillar, domed, rill, and vertical face. Filled stopes: flat back, dry wall and cross cut. Shrinkage stopes: definition, method, limitations. Caving methods: top slicing, sub level caving, block caving. Coal Mining Methods: board and pillar; longwall advance and retreat; horizon. Mine ventilation. Mined land reclamation; Health hazards; Coal mining hazards and acid mine drainage. Environmental impact of mining.

UNIT IV **ORE DRESSING**

Ore beneficiation: definition and scope. General operating steps in ore dressing. Size reduction of ores:- jaw crushers: definition; types – gyratory, cone, rolls, gravity stamps, and special types. Laboratory sizing: definition, role of particle shape, sizing scale and graphical representation. Screening technique: hand, automatic, wet and dry. Classification technique: sedimentation, flocculation and centrifuging methods. Average size.

UNIT V

Liberation of ore from gangue: size reduction, detachment, locked particles and degree of liberation. Grinding: definition and methods – ball mills, rod mills, and tube mills. Froth floatation: reagents, collectors, frothers, modifiers. Magnetic and electrostatic methods. Separation of solids

suspended in fluids: classifiers- spiral classifiers, centrifugal. Gravity concentration: jigging, spiralling, tabling, sink – flotation process. Flow sheets for ore beneficiation.

REFERENCE & TEXTBOOKS

1. Arogyaswamy, R.N.P. (1988). Courses in Mining Geology, Oxford & IBH, New Delhi.
2. Singh,R.D. (1998). Coal Mining. New Age Publishers, Delhi.
3. Thomas,R.T. (1986). Introduction to Mining Methods. McGraw Hill, New York.
4. Peters,W.C. (1978). Exploration and Mining Geology, Wiley, New York.
5. Hartman,H.L.(1992).SME Mining Engineering Handbook, SME Colorado, USA.
6. McKinstry, H.E.(1948).Mining Geology, Asia Publishing House, Delhi.
7.Gaudin,A.M. (1939). Principles of Mineral Dressing. TMH. Delhi.
8.Banerjee,P.K.(1997).Elements of Prospecting for Non Fuel Mineral Deposits. Allied. Madras.
9. IBM. (1980). Elements of Mineral Exploration. IBM. Nagpur.
10. IBM. (1990). Manual for Mining Geologists. IBM. Nagpur.
11. Wills, B.A. (2006). Mineral Processing technology. Elsevier. Delhi.Gems. Elsevier, Singapore.
12. Gokhale, K.V.G.K. & D.M.Rao.(1981). Ore Deposits of India. Oxford & IBH. Delhi.

Web resources: The student can approach the Teacher concerned for relevant and recommended web resources including Inflibnet and NLIST resources available in the Department.

Additional Resources: Soft copies related study materials are available in the Department for access with proper permission from the Teacher concerned.

A**ssignments:** Any two assignments (within the five units) may be suggested by the Teacher.

Suggested Group Work/Tasks: Supervised field visits are suggested with the submission of a field report.

S. No.	COURSE & LEARNING OUTCOMES	
CO1	The student is introduced to a detailed discussion, study, and application of preparing mining geology report and mine plans; mine valuation; classification, estimation, and evaluation of ore bodies for mining; open cast mining methods;	Remember, understand, apply, and

	open cast mining equipment; and mechanised mining.	assess.
CO2	The student is introduced to a detailed discussion, study and application of mine operations: drilling; removal of broken ores and rock: manual and mechanised; alluvial mining methods; quarrying methods; subsurface mining methods.	Understand, apply, and assess.
CO3	The student is introduced to a detailed discussion, study, and applications of subsurface mining methods; mine ventilation.	Understand, apply, and assess.
CO4	The student is introduced to a detailed discussion, study and application of ore beneficiation techniques.	Understand, apply, and assess.
CO5	The student is introduced to a detailed discussion, study and application of ore liberation methods: grinding; froth floatation methods; magnetic & electrostatic methods; separation of solids suspended in fluids; gravity concentration and flow sheets for ore beneficiation.	Understand, apply, and assess.

MAPPING WITH PROGRAM OUTCOMES (S – Strong; M- Medium; L-Low)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	S	S	M	S	S
CO2	S	S	M	M	M	S	S	M	S	S
CO3	S	S	M	M	M	S	S	M	S	S
CO4	S	S	M	M	M	S	S	M	S	S
CO5	S	S	M	M	M	S	S	M	S	S

Course Code	Paper Title	Lectures	Tutorials	Practical	Credits
21PGL11	ENGINEERING GEOLOGY & ENVIRONMENTAL GEOLOGY	4	1	-	5

Broad Objectives & Teaching Methodology:

Engineering geology is the application of relevant geological principles, procedures, and investigations in civil and military engineering projects. Engineering geology aims to introduce the student to the role of a geologist in the engineering planning and execution of dams, tunnels, foundations, bridges, roads, and landslide safety and stability. Environmental geology is the application and role of geology in the environmental perspective. The teaching methodology is done via class room lectures, use of physical models, pictures, multi media resources, interactive sessions, student involvement sessions with practical and laboratory demonstrations, field visits and others.

UNIT I **ENGINEERING GEOLOGY**

Engineering properties of rocks: - compressive strength- tensile strength-flexural strength-Young's modulus and Poisson's ratio- residual stresses in rocks. Geotechnical significance of fault & folds in engineering geology. Engineering properties of soils; size of soil particles - gradation-shape-structure-cohesion. Alteration of clay structure. Engineering problems in loess areas. Engineering significance of alluvial deposits.

UNIT II

Foundations: definition, types, settlement of foundations, geological conditions, and site investigations. Bearing capacity and pile foundations. Short note on bridge foundations and geological conditions. Hill slopes- forms in relation to lithology and structural weakness in rocks; control and mass movement, modification by overland flow of hill slopes. Slope stability studies. Engineering significance of swamps- Residual soil.

UNIT III

Dams: definition, types, geological conditions, and site investigations. Short note on dam foundations and geological conditions. Outline of important Indian Dams and their role in maintaining water supply. Tunnels: definition, parts of a tunnel, types, tunnelling in hard and soft rocks, geological investigations, and groundwater conditions. Outline of tunnel support structures: rods, bolts, anchors, arches, rings, linings, and retaining walls.

UNIT-IV **ENVIRONMENTAL GEOLOGY**

Classification and types of natural resources. Renewable and non renewable resources. Impact of man on the environment. Groundwater pollution: definition, types and remedial measures. Geological factors in environmental health. Trace elements and human health. Chronic disease and geological environment.

UNIT V

Environmental impact due to mining and mineral processing and its remediation. Coastal environments: definition, pollution in coastal areas, prevention of erosion along coasts. Types of human generated waste and outline of methods of disposal. Outline of Environmental law in India.

REFERENCE BOOKS AND TEXT BOOKS:

1.Bell, F.G. (2005). Fundamentals of Engineering Geology. B.S. Publications, Hyderabad.

2.Krynine,P.D (1956). Principles of Engineering Geology and Geotechnics. CBS,Delhi.

3.Legget,R.F. (1988). Geology and Engineering. 3rd ed. McGraw Hill, New York.

4.Singh,P.B. (2005). A Textbook of Engineering and General Geology. S.K.Kataria & Sons,Delhi.

5.Blyth,F.G.H. & M.H. De Freitas. (1984). A Geology for Engineers. 7th ed. Elsevier, New Delhi.

6.Gokhale, K.V.G.K. (1981), Experiments in Engineering Geology, McGraw Hill. Delhi.

7.Keller,E.A.(1985). Environmental Geology. Merill. New York.

8.Flawn,P.T. (1970). Environmental Geology. Harper.New York.

9.Coates,D.R. (1984). Environmental Geology. McGraw Hill. New York.

10. Montgomery, C.W.(2011). Environmental Geology. McGraw Hill. Delhi.

Web resources: The student can approach the Teacher concerned for relevant and recommended web resources including Inflibnet and NLIST resources available in the Department.

Additional Resources: Soft copies related study materials are available in the Department for access with proper permission from the Teacher concerned.

A**ssignments:** Any two assignments (within the five units) may be suggested by the Teacher.

Suggested Group Work/Tasks: Supervised field visits are suggested with the submission of a field report.

S. No.	COURSE & LEARNING OUTCOMES	
CO1	The student is introduced to a detailed discussion, study, and application of engineering properties of rocks; geotechnical significance of fault & folds; engineering properties of soils; engineering problems in loess areas and engineering significance of alluvial deposits.	Remember, understand, apply, and assess.
CO2	The student is introduced to a detailed discussion, study, and application of foundations; hill slopes; slope stability studies; engineering significance of swamps; residual soil;	Understand, apply, and assess.
CO3	The student is introduced to a detailed discussion, study, and application of dams and tunnels.	Understand, apply, and assess.
CO4	The student is introduced to a detailed discussion, study, and application of classification and types of natural resources; renewable and non renewable resources; impact of man on the environment; groundwater pollution; geological factors in environmental health; trace elements and human health; and chronic disease and geological environment.	Understand, apply, and assess.
CO5	The student is introduced to a detailed discussion, study, and application of energy resources; environmental impact due to mining and mineral processing; coastal environments; human generated waste and methods of disposal; and outline of Environmental law in India.	Understand, apply, and assess.

MAPPING WITH PROGRAM OUTCOMES (S – Strong; M- Medium; L-Low)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	M	S	S	S	S	S
CO2	S	S	S	M	M	S	S	S	S	S
CO3	S	S	S	M	M	S	S	S	S	S
CO4	S	S	S	M	M	S	S	S	S	S
CO5	S	S	S	M	M	S	S	S	S	S

Course Code	Paper Title	Lectures	Tutorials	Practical	Credits
21PGL12	REMOTE SENSING & GIS	4	1	5	5

Broad Objectives & Teaching Methodology:

Remote sensing is the observation of earth's surface features via scaled aerial photographs and imageries obtained from aircraft and satellites fitted with specifically manufactured sensors and camera equipment. The broad applicability of remote sensing in the geological sciences is emphasized in this course. The student is introduced to the basic elements and techniques of remote sensing and GIS along with their applications and limitations. The teaching methodology is done by class lectures, use of models, multimedia resources, practical demonstrations emphasizing: types of instruments used for viewing and interpreting aerial photographs, satellite images, and others.

UNIT – I

Energy sources -Interaction with atmosphere and earth- Characteristics of remote sensing systems - Introduction to the types of satellites and orbits. Resolution of satellites; Multispectral scanning: types, multispectral detectors and sensors, LANDSAT, SPOT, and IRS sensors. Thermal Remote Sensing: Planck' s blackbody law, displacement law and emissivity effects, heat capacity, thermal conductivity, thermal inertia, diurnal heat effects, thermal property of objects, thermal sensors, thermography, thermal image interpretation.

UNIT- II

Microwave Remote sensing: active and passive remote sensing, components, image characteristics, radiometric and geometric aspects of characteristics, SAR, SLAR, SRTM. Advantages of radar Interferometry. Outline of passive microwave remote sensing. Introduction to Hyperspectral remote sensing and its applications. Outline of LIDAR.

UNIT- III

Visual interpretation and identification of drainages, landforms and rock types using satellite images. Application of remote sensing in mineral targeting-petroleum exploration- structural geology and tectonics. Applications of remote sensing natural hazard management and mitigation. Basic idea on maps and map projections.

UNIT – IV

GIS I : Definition, components of GIS, computer hardware, software modules and organizational context of GIS. Data structure in GIS - types of data, data base structures, data conversions, **Data Input, Verification, Storage and Output**: spatial data input processes and devices, sources of data, detailed types of data entry: entry of non-spatial data; linking of spatial & non-spatial data; Data verification and errors, correction, GIS capabilities for data correction, data output: types, GIS capabilities and output devices.

UNIT – V

GIS II: Data Analysis and Spatial Modelling: data retrieval: simple, Boolean Logic. Map Overlays and Cartographic Modelling: two layers, multiple layers, binary, index, regression, and process models; Overlay analysis, buffering, network analysis. Digital Elevation Modelling: advantages of 3D models, Methods of DEM - Products of DTM. Usefulness of DEM/DTM.

REFERENCE AND TEXTBOOKS

1. Anon. (1983). Manual of Remote Sensing, ASP, Falls Church, Virginia.USA.

2. Bhatt,A.B.(1994). Aerial Photography & Remote Sensing, BS & MPS Pub.Delhi.

3.Burrough,P.A. (1986). Principles of GIS for Land Resources Assessment. OUP. Delhi

4.Rampal,S. (1999). Handbook of Aerial Photography and Interpretation, Concept publishing.

5.Lillesand T.M.,(2000). Remote Sensing and Image interpretation. Wiley. Delhi

6.Jensen,J.R.(1995).Introductory Digital Image Processing. Wiley. Delhi.

7.Richards,J.A. (1999). Remote Sensing Digital Image Analysis. Springer. Delhi.

8. Curran,P.J. (1995). Principles of Remote Sensing. ELBS. London.

9. Sabins, F.F.(1978). Remote Sensing Principles and Image interpretation, Freeman. USA.

10. Chang, K.T. (2006). Introduction to Geographic Information Systems, Pearson. Delhi.

Web resources: The student can approach the Teacher concerned for relevant and recommended web resources including Inflibnet and NLIST resources available in the Department. **Additional Resources:** Soft copies related study materials are available in the Department for access with proper permission from the Teacher concerned. A**ssignments:** Any two assignments (within the five units) may be suggested by the Teacher. **Suggested Group Work/Tasks:** Supervised field visits are suggested with the submission of a field report.

S. No.	COURSE & LEARNING OUTCOMES	
CO1	The student is introduced to a detailed discussion on the basic theory, principles, and instruments, of remote sensing and thermal remote sensing;	Remember, understand, apply, and assess.
CO2	The student is introduced to a detailed discussion on the basic theory, principles, and instruments, of microwave remote sensing; hyperspectral remote sensing and LIDAR.	Understand, apply, and assess.
CO3	The student is introduced to a detailed discussion on the basic theory, principles, and applications of image interpretation and identification of drainages, landforms, rock types, mineral targets, petroleum exploration, structural geology, tectonics, natural hazard management and mitigation along with a basic idea on maps and map projections.	Understand, apply, and assess.
CO4	The student is introduced to a detailed discussion on the basic theory, principles, and applications of GIS I	Understand, apply, and assess.
CO5	The student is introduced to a detailed discussion on the basic theory, principles, and applications of GIS II.	Understand, apply, and assess.

MAPPING WITH PROGRAM OUTCOMES (S – Strong; M- Medium; L-Low)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	S	S	M	M	M	S
CO2	S	M	S	S	S	S	M	M	M	S
CO3	S	M	S	S	S	S	M	M	M	S
CO4	S	M	S	S	S	S	M	M	M	S
CO5	S	M	S	S	S	S	M	M	M	S

21PGLPR	PROJECT WORK	Credits 12

Topic

Each student shall choose his/her project supervisor by the random lot method before the end of first/second semester. The broad field or provisional title for the project shall be assigned to the candidate(s) by their Supervisors and a list of the same shall be submitted to the Head of Department. The list finalized and approved by the Head of Department is binding, final and non-negotiable.

Plan of Work

The student(s) shall prepare a viable plan of work for the dissertation and get the approval of the Supervisor(s). The student(s) should start the project work from the end of the first/second semester and submit the project report at the time of viva-voce examination at the end of the fourth semester. The mandatory periodic reviews of the work progress of the student(s) will be monitored by the supervisors and Head of Department. The project report shall be duly certified by the Supervisor and the Head of the Department. Students who secure sponsored projects from outside agencies, e.g. TANCSHE and others may submit the same as a regular project work under this course code for the viva with the written approval of the Supervisor and Head of Department.

Dissertation work outside the College

In case the student(s) needs to avail facilities outside the college, (i.e.) from other University / Laboratory, they shall pursue the work with the approval and permission of both the Supervisor and the Head of Department and properly acknowledge the outside facilities utilised by them. The student shall complete the project work on or before the commencement of the Main Practical examinations or 31st March of the calendar year, which ever comes first. Mandatory approval/permission of the College Principal/DCE shall be obtained when the student works for his/her project outside the College for a period exceeding more than consecutive two weeks or fourteen days (excluding Government holidays).

Submission of Dissertation

The student shall prepare 2 copies of the project work and submit the same at the time of viva – voce, for evaluation by the Examiners. After evaluation, a soft copy of the dissertation is to be submitted to COE and Department Library.

Marks for Dissertation

The total marks for dissertation shall be 200, of which 150 marks are for project work and 50 marks for viva-voce. The regulations for the end semester practical are also applicable to this course.

Course Code	Paper Title	Lectures	Tutorials	Practical	Credits
21PGLM1	PETROLEUM GEOSCIENCES	2	1	-	4

Broad Objectives & Teaching Methodology:

Petroleum geoscience as a major based elective that introduces the student to petroleum and natural gas deposits followed by a detailed study of their their geological characteristics, mode of occurrence, stratigraphic significance, origin, suggested genesis, and their Indian distribution. Petroleum geoscience is related to stratigraphy, geophysical exploration methods, exploration geology, well logging and others. The teaching methodology is a combination of class room lectures, use of physical models, pictures, multi media resources, interactive sessions, student involvement sessions with practical and laboratory demonstrations, field visits and others.

UNIT I

Petroleum: definition, and its different states of natural occurrence. Detailed study of the origin of petroleum; Descriptive study of the geochemistry and maturation of kerogen; biogenic and thermal effects. Outline of distribution of petroleum in space and geological time.

UNIT II

Petrographic and geochemical methods of petroleum exploration. Petrographic and microscopic organic analysis, thermal alteration index, vitrinite reflectance; Geochemical: combustion methods – carbon ratio, TOC, stable isotope method, TTI, Arrhenius equation, Lopatin's method, concept of cooking time, LOM, and rock eval pyrolysis method

UNIT III

Descriptive study of migration of oil and gas: geologic framework of migration; short and long distance migration, primary and secondary migration; geologic factors controlling migration; forces responsible for migration, migration routes and barriers.

UNIT IV

Detailed study of reservoir rocks: general attributes and petrophysical properties. Classification of reservoir rocks, types of clastic and carbonate reservoirs. Short account of reservoir characterization and blowout problem. Descriptive study of hydrocarbon traps: definition; classification of hydrocarbon traps - structural, stratigraphic and combination type of trap formation and time of hydrocarbon accumulation.

UNIT V

Oil field water- characters and classifications. Cap rocks: definition and general properties. Petroleum Geology of important Indian basins. Outline of oil and gas exploration with reserve estimation. Short account of well logging techniques relevant to petroleum exploration.

REFERENCE BOOKS

1. Levorsen, A.A. (1967). Geology of Petroleum. CBS. New Delhi.
2. Selley, R.C. (1998). Elements of Petroleum Geology. Academic Press. Delhi.
3. North, F.K. (1990). Petroleum Geology. Unwin Hyman. Delhi.
4. Chapman, R.E. (1983). Petroleum Geology. Elsevier. Delhi.
5. Thomas, L. (2013). Coal Geology. Wiley Blackwell. New Delhi.
6. Tissot, B. P.(1984).Petroleum Formation and Occurrence. Springer-Verlag, Germany.

TEXT BOOKS

1. Prasad, U. (2003). Economic Mineral Deposits. CBS. New Delhi.

2. Banerjee, D.K. (1998). Mineral Resources of India. World Press. Kolkata.

3. Deb, S. (1985). Industrial Minerals & Rocks of India. Oxford & IBH India. Delhi.

4. Krishnasamy, S. (1988). India's Mineral Resources. Oxford & IBH India. Delhi.

5. Sharma, N.L. & R.K.Sinha. (1985). Mineral Economics. Oxford & IBH India. Delhi.

6. Aswathanarayana, U. (1985). Principles of Nuclear Geology. NBT. Delhi.

Web resources: The student can approach the Teacher concerned for relevant and recommended web resources including Inflibnet and NLIST resources available in the Department.

Additional Resources: Soft copies related study materials are available in the Department for access with proper permission from the Teacher concerned. A**ssignments:** Any two assignments (within the five units) may be suggested by the Teacher. **Suggested Group Work/Tasks:** Supervised field visits are suggested with the submission of a field report.

S. No.	COURSE & LEARNING OUTCOMES	
CO1	The student is introduced to petroleum with a detailed study of its origin, kerogen and distribution of petroleum in space and geological time.	Remember, understand, apply, and assess.
CO2	The student is introduced to the different petrographic and geochemical methods of petroleum exploration along with their applications and limitations.	Understand, apply, and assess.
CO3	The student is introduced to the descriptive study and different mechanisms of migration of oil and gas as relevant to the petroleum industry.	Understand, apply, and assess.
CO4	The student is introduced to a detailed study of reservoir rocks; their characterization, blowout problems along with a detailed description of petroleum traps.	Understand, apply, and assess.
CO5	The student is introduced to a detailed study and application of oil field waters and cap rocks. The petroleum geology of important Indian basins is discussed with an outline of oil and gas exploration with reserve estimation. A short account of well logging techniques relevant to petroleum exploration is also discussed.	Understand, apply, and assess.

MAPPING WITH PROGRAM OUTCOMES (S – Strong; M- Medium; L-Low)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	S	M	S	M	L	S	S
CO2	S	M	M	S	M	S	M	L	S	S
CO3	S	M	M	S	M	S	M	L	S	S
CO4	S	M	M	S	M	S	M	L	S	S
CO5	S	M	M	S	M	S	M	L	S	S

Course Code	Paper Title	Lectures	Tutorials	Practical	Credits
21PGLM2	GEOLOGY OF TAMIL NADU	2	1	-	4

Broad Objectives & Teaching Methodology:

This course introduces to the student the detailed geology and stratigraphy of Tamil Nadu, and is related in general, to mineral exploration, economic geology, structural geology and others. This course reasonably prepares the student to appear in several geology related competitive examinations including those conducted by State and Central Public Services with confidence, whilst providing a base for other future jobs and opportunities relevant to the geological sciences.

The teaching methodology is a combination of class room lectures, use of physical models, pictures, multi media resources, interactive sessions, student involvement sessions with practical and laboratory demonstrations, supervised field visits and others.

UNIT I Geomorphology of Tamil Nadu:

Hill systems and their ranges, rivers and their drainage systems, and plains. Coastal geomorphology of Tamil Nadu: beaches, shorelines, estuaries and lagoons. Stratigraphic time scale of Tamil Nadu. Outline of the structure and tectonics of Tamil Nadu. Brief account of prominent shear zones of Tamil Nadu: Moyar, Bhavani, Dharmapuri, Cauvery, Salem-Attur, Gangavelli, and Achankoil. Soils of Tamil Nadu: origin, types, and soil profiles.

UNIT II Archaean of Tamil Nadu.

Nomenclature, lithology, structure and distribution of the following: Sathyamangalam Group – Bhavani Gneissic Complex – Khondalite group of Madukkarai and Alagan Hills – Kolar Schist belt of Dharmapuri district. Anorthosite complexes of Tamil Nadu: Sittampundi – Oddanchatram – Kadavur – Bhavani – Mamandur.

UNIT III Proterozoic of Tamil Nadu.

Nomenclature, lithology, structure, age and distribution of: Pallavaram charnockite – Migmatites. Basic dyke swarms: petrology, distribution and associated host rocks. Petrology, distribution and associated host rocks of Ultramafic rock complexes: Chalk Hills, Torappadi, Sirapalli and Bhavani. Petrology, distribution and associated host rocks of Alkaline-mafic rock complexes: Elagiri, Samalpatti, Pakkanadu, Sivanmalai, and Hogenakkal. Petrology, distribution and associated host rocks of Granites: Marudamalai, Tiruchengodu, Gingee, and Pudukottai.

UNIT IV Gondwana & Cretaceous of Tamil Nadu

Stratigraphy, lithology, distribution, and outline of fossil content of the following: Lower Gondwana formations: Talchir rocks of Palar basin and Sriperumpudur.Upper Gondwana formations: Sivagangai formation, Terani and Uttatur formations.Cretaceous of Tiruchirapalli.

UNIT V Tertiary & Quarternary of Tamil Nadu.

Stratigraphy, lithology, distribution, and outline of fossil content of the following: Tertiary formations – Cuddalore, Panamparai, and Kanniyakumari.Stratigraphy, lithology, distribution, and outline of fossil content of the following:Quarternary formations: Pliocene formations of Kumbum, Theni and Madurai districts.Outline description of Teri sands and their distribution.

REFERENCE AND TEXTBOOKS

1. Subramanian, K.S & T.A.Selvan. (2001). Geology of Tamil Nadu & Pondicherry.

Geol. Soc. Ind. Bangalore.

2. GSI. (2014). Geology and Mineral Resources of Tamil Nadu & Pondicherry. Miscellaneous Publication No. 30, 3rd revised edition. Geological Survey of India. Kolkata.

3. Vaidyanadhan, R & M. Ramakrishnan. (2008). Geology of India. Geol. Soc. Ind. Bangalore.

4. Wadia, D.N. (1953). Geology of India. McMillan India. Delhi.

5. Kumar, R.(2008). Fundamentals of Historical Geology and Stratigraphy of India, Wiley. New Delhi.

6. Krishnan, M.S. (1986). Geology of India, Burma and Pakistan. CBS. New Delhi.

Web resources: The student can approach the Teacher concerned for relevant and recommended web resources including Inflibnet and NLIST resources available in the Department.

Additional Resources: Soft copies related study materials are available in the Department for access with proper permission from the Teacher concerned. A**ssignments:** Any two assignments (within the five units) may be suggested by the Teacher. **Suggested Group Work/Tasks:** Supervised field visits are suggested with the submission of a field report.

S. No.	COURSE & LEARNING OUTCOMES	
CO1	The student is introduced to the different geomorphic units and features of Tamil Nadu. The stratigraphic time scale, structure and tectonics, prominent shear zones, and soils of Tamil Nadu are discussed in detail.	Remember, understand, apply, and assess.
CO2	The student is introduced to the different Archaean formations of Tamil Nadu with a detailed discussion of their salient geological features.	Understand, apply, and assess.
CO3	The student is introduced to the different Proterozoic formations of Tamil Nadu with a detailed discussion of their salient geological features.	Understand, apply, and assess.
CO4	The student is introduced to the different Gondwana & Cretaceous formations of Tamil Nadu.	Understand, apply, and assess.
CO5	The student is introduced to the different Tertiary & Quarternary formations of Tamil Nadu.	Understand, apply, and assess.

MAPPING WITH PROGRAM OUTCOMES (S – Strong; M- Medium; L-Low)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	M	S	M	M	S	S
CO2	S	S	S	S	M	S	M	M	S	S
CO3	S	S	S	S	M	S	M	M	S	S
CO4	S	S	S	S	M	S	M	M	S	S
CO5	S	S	S	S	M	S	M	M	S	S

Course Code	Paper Title	Lectures	Tutorials	Practical	Credits
21PGLM3	PROBLEMS IN GEOLOGY FOR COMPETITIVE EXAMINATIONS	2	1	-	4

Broad Objectives & Teaching Methodology:

This course introduces to the student the mathematical problems commonly met during the teaching of the various courses. These problems may also be useful for preparing for geology related competitive examinations including those conducted by State and Central Public Services. The teaching methodology is a combination of class room lectures, problems set, work book exercises, multi media resources, and others.

UNIT I

Structural Geology & Tectonics: Calculation of dip, strike and net slip of faults. Problems related to Mohr's circle, Anderson's theory of faulting, and quadratic elongation. Problems based on stereographic projection. Problems related to plate tectonics: plate velocity, Euler poles, and rate of spreading. **Engineering geology**: RQD, RMC, and uniaxial compressive strength. **Remote sensing**: focal length of camera and area calculation on scaled photographs. **Economic geology**: metallic content, grade of ore body: average and ore drive sample grade.

UNIT-II

Hydrogeology: Calculation of porosity and pore space, void ratio, liquidity index, and ionic strength. Estimation of groundwater storage and volume of precipitation. Simple problems based on drainage networks and stream orders. Problems related to Darcy's Law: hydraulic conductivity, flow rate and velocity, groundwater flow direction using water table contours, aquifer thickness and transmissivity, and coefficient of permeability. Problems based on Ghyben – Herzberg relations, pump tests, and tracer tests.

UNIT III

Gravity method: Basic gravity problems: polar flattening and mass of bodies. Corrections to raw gravity data. Gravity anomalies: half width anomaly, spherical ore bodies and cylindrical ore bodies. Problems based on Isostasy. **Electrical methods**: basic electrical properties: apparent resistivity, reflection coefficient, coefficient of electrical anisotropy, transverse resistivity, transverse resistance, longitudinal conductance, longitudinal resistivity. Problems related to Wenner, Schlumberger, axial dipoles field configurations and IP surveys.

UNIT IV

Electromagnetic Method: problems based on skin depth, gyromagnetic ratio, and Larmor precession. Palaeomagnetism: calculation of paleomagnetic latitude. **Well Logging**: estimation of formation factor, transmission coefficient, estimation of shale using GR log, and formation water saturation, porosity based on Archie's relation, porosity, formation water resistivity, and true resistivity of formation.

UNIT V

Seismology: EQ seismic energy, moment magnitude, epicentral distance, Poisson's ratio, Young's modulus and bulk modulus, geophone spacings, foldage, reflection surveys: reflection and transmission coefficient, travel time, interval velocity, depth of reflector, and dip of reflector, normal moveout; refraction surveys: depth of bedrock, critical angle, and signal aliasing. **Radioactive methods**: calculation of age of sample using ratios,, half life, and decay constant. **Heat flow**: Birch's formula, geothermal gradient, heat flow value, and radioactive heat generation.

REFERENCES AND TEXTBOOKS

1.Ramsay, J.G. & M.I.Huber.(1983).The Techniques of Modern Structural Geology, AP. UK.

2.Davis, G.H., & S.J.Reynolds.(1996). Structural Geology of Rocks and Regions, Wiley. Delhi.

3.Park, P.G.(1983).Foundations of Structural Geology, Blackie. London.

4. Ghosh, S.K. (1993). Structural Geology. Elsevier. Delhi.

5. Ragan, D.M. (2000). Structural Geology. 2nded. Wiley. New York.

6. Fossen, H. (2010). Structural Geology. Cambridge University Press. New Delhi.

7.Price, N.J. and J.W.Cosgrove.(1990). Analysis of Geological Structures. Chapman & Hall. UK.

8. Lisle, R.J & Peter R Leyshon. (2004). Stereographic Projection Techniques. CUP. Delhi.

9.Moore,E. and R.J.Twiss. (1995). Tectonics. Freeman. New York.

10. Keary,P and F.J.Vine. (1990); - Global Tectonics. Cambridge University Press. Delhi.

11. Todd, D.K. (2008). Groundwater Hydrology. 5th ed. Wiley. New Delhi.

12. Davis, S.N. & R.J.M. DeWiest. (1966). Hydrogeology. Wiley. Delhi.

13. Freeze, R.A. & J.A.Cherry. (1979).Groundwater. Prentice Hall. New York.

14. Raghunath, H.M. (1988). Groundwater. East West Pub. Delhi.

15. Fetter, G.W. (1989). Applied Hydrogeology. CBS. Delhi.

16. Ramakrishnan, S. (2011). Ground Water. Scitech Publications. Chennai.

17. Garg, S.P. (1982). Groundwater and Tube Wells. Oxford & IBH. Delhi.

18. Hiscock, K.M.(2005). Hydrogeology. Blackwell Science. Delhi.

19. Ramachandra Rao, M.B. (1993). Outlines of Geophysical Prospecting. EBD. Dhanbad.

20. Kearey, P. & Others. (2002). An Introduction to Geophysical Exploration. Wiley. Delhi.

21.Mussett,A.E. & Khan,M.A. (2000). Looking into the Earth. CUP. New Delhi.

22.Lowrie,W. (2020). Fundamentals of Geophysics. 3rd edition. CUP. New Delhi.

23.Sharma,P.V. (1997). Environmental and Engineering Geophysics. CUP. Delhi.

24. Banerjee,P.K. (1997). Elements of Prospecting for Non Fuel Mineral Deposits. AP. Chennai.

25.Moon,C.J; & Others. (2006). Introduction to Mineral Exploration. Wiley. Delhi.

26. Milsom,J (2011). Field Geophysics. Wiley. Delhi.

27. Ellis, D.V. & Singer.J.M. (2008). Well logging for Earth Scientists. Springer .Delhi.

28. Asquith,G. (1982). Basic Well Log Analysis for Geologists. AAPG. Oklahoma.

Web resources: The student can approach the Teacher concerned for relevant and recommended web resources including Inflibnet and NLIST resources available in the Department.

Additional Resources: Soft copies related study materials are available in the Department for access with proper permission from the Teacher concerned.

A**ssignments:** Any two assignments (within the five units) may be suggested by the Teacher.

S. No.	COURSE & LEARNING OUTCOMES	
CO1	The student is introduced to the basic theory and problems pertaining to: structural geology & tectonics, engineering geology, remote sensing, and economic geology.	Remember, understand, apply, and assess.
CO2	The student is introduced to the basic theory and problems pertaining to hydrogeology.	Understand, apply, and assess.
CO3	The student is introduced to the basic theory and problems pertaining to gravity and electrical geophysical methods.	Understand, apply, and assess.
CO4	The student is introduced to the basic theory and problems pertaining to electromagnetic methods and well logging.	Understand, apply, and assess.
CO5	The student is introduced to the basic theory and problems pertaining to seismology, radioactive methods, and heat flow.	Understand, apply, and assess.

MAPPING WITH PROGRAM OUTCOMES (S – Strong; M- Medium; L-Low)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	-	-	M	S	S	S	M	S	S
CO2	S	-	-	M	S	S	S	M	S	S
CO3	S	-	-	M	S	S	S	M	S	S
CO4	S	-	-	M	S	S	S	M	S	S
CO5	S	-	-	M	S	S	S	M	S	S

Course Code	Paper Title	Lectures	Tutorials	Practical	Credits
21PGLM4	MINERAL RESOURCES OF INDIA	2	1	-	4

Broad Objectives & Teaching Methodology:

This course introduces to the student the different ore and mineral deposits and their resources of India. The detailed geology along with ore mineralogy, association, genesis, mode of occurrence, reserves, and Indian distribution are discussed in reasonable detail. This course is closely related to mining geology, mineral exploration, economic geology, structural geology and others. This course fairly prepares the student to appear in several geology related competitive examinations including those conducted by State and Central Public Services with confidence, whilst providing a base for other future jobs and opportunities relevant to the geological sciences.

The teaching methodology is a combination of class room lectures, use of physical models, pictures, multi media resources, interactive sessions, student involvement sessions with practical and laboratory demonstrations, supervised field visits and others.

UNIT I

Ore mineralogy, guides for exploration, deposit types, mode of occurrence, petrological association, genesis, reserves, uses, and Indian distribution of: PGE, Gold, Iron, Manganese, Chromium.

UNIT-II

Ore mineralogy, guides for exploration, deposit types, mode of occurrence, petrological association, genesis, reserves, uses, and Indian distribution of: Vanadium, Molybdenum, Tungsten, Nickel, Cobalt, Titanium.

UNIT III

Ore mineralogy, guides for exploration, deposit types, mode of occurrence, petrological association, genesis, reserves, uses, and Indian distribution of: Copper, Lead & Zinc, Tin, Niobium-Tantalum, and Aluminium.

UNIT IV

Ore mineralogy, guides for exploration, deposit types, mode of occurrence, petrological association, genesis, reserves, uses, and Indian distribution of: Uranium, Thorium, Mercury, Nuclear minerals, and REE.

UNIT V

Economic mineralogy, guides for exploration, deposit types, mode of occurrence, petrological association, genesis, reserves, uses, and Indian distribution of minerals used in the following industries: abrasive, ceramic, glass, paint and pigments, fertilizers, and cement. Outline of building and dimension stones.

REFERENCES AND TEXTBOOKS

1. Aiyengar,N.K.N.(1964). Minerals of Madras. Dept. of Indus & Comm. Guindy, Madras.
2. Krishnan,M.S. (1951). Mineral Resources of Madras. Memoir V.80. Geol.Surv.Ind. Kolkata.
3. Prasad,U. (2003). Economic Mineral Deposits. CBS. Delhi.
4. Banerjee,D.K. (1998). Mineral Resources of India. World Press. Kolkata.
5. Deb,S.(1985). Industrial Minerals and Rocks of India. Oxford & IBH. Delhi.
6. Krishnasamy,S. (1988). India’s Mineral Resources. Oxford & IBH. Delhi.

7. Sharma,N.L & R.K.Sinha. (1985), Mineral Economics. Oxford & IBH.Delhi.

8. Gokhale,K.V.G.K.&D.M.Rao.(1981).Ore Deposits of India. Oxford & IBH.Delhi.

9. Deb,M & Sarkar.S.C. (2017).Minerals & Allied Natural Resources. Springer. Delhi.

10. IBM. (1989). Elements of Mineral Exploration. IBM. Nagpur.

11. Singanenjam, S. (2014). Misc. Pub. No. 30. Part.6. Geol. Surv. India. Kolkata.

Web resources: The student can approach the Teacher concerned for relevant and recommended web resources including Inflibnet and NLIST resources available in the Department.
Additional Resources: Soft copies related study materials are available in the Department for access with proper permission from the Teacher concerned.
A**ssignments:** Any two assignments (within the five units) may be suggested by the Teacher.
Suggested Group Work/Tasks: Supervised field visits are suggested with the submission of a field report.

S. No.	COURSE & LEARNING OUTCOMES	
CO1	The student is introduced to the detailed study, identification, recognition, uses and applications of the ore deposits related to PGE, Gold, Iron, Manganese, and Chromium.	Remember, understand, apply, and assess.
CO2	The student is introduced to the detailed study, identification, recognition, uses and applications of the ore deposits related to Vanadium, Molybdenum, Tungsten, Nickel, Cobalt, Titanium.	Understand, apply, and assess.
CO3	The student is introduced to the detailed study, identification, recognition, uses and applications of the ore deposits related to Copper, Lead & Zinc, Tin, Niobium-Tantalum, and Aluminium.	Understand, apply, and assess.
CO4	The student is introduced to the detailed study, identification, recognition, uses and applications of the ore deposits related to Uranium, Thorium, Mercury, Nuclear minerals, and REE.	Understand, apply, and assess.
CO5	The student is introduced to the detailed study, identification, recognition, uses and applications of the mineral deposits related to abrasive, ceramic, glass, paint and pigments, fertilizers, and cement. Outline of building and dimension stones.	Understand, apply, and assess.

MAPPING WITH PROGRAM OUTCOMES (S – Strong; M- Medium; L-Low)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	M	S	S	M	S	S
CO2	S	S	S	S	M	S	S	M	S	S
CO3	S	S	S	S	M	S	S	M	S	S
CO4	S	S	S	S	M	S	S	M	S	S
CO5	S	S	S	S	M	S	S	M	S	S

Course Code	Paper Title	Credits
21PGLP1	STRUCTURAL GEOLOGY, STRATIGRAPHY, REMOTE SENSING & GIS	4

Structural Geology Practical:

Preparation of geological maps from topographical maps and its interpretation. Trigonometrical solutions to fault problems. Determination of true thickness of beds and depth to a bed from a level or sloping surface. Calculation of true dip and apparent dip of a bed. Stereographic projection: Representing inclined planes, horizontal and vertical planes in a stereogram. Determination of dip, apparent dip of a bed, representing the intersecting planes in a stereogram. Solving the fold, fault and unconformity problems by stereographic projection method.

Stratigraphy Practical

Correlation of strata using lithographic columns and fence diagrams. Interpretation of age relations using cross section diagrams. Graphical identification of missing beds or unconformities using lithographic logs or columns. Chronological study of important fossiliferous rocks. Determination of order of superposition using primary and secondary structures using lithology or stratigraphic columns. Stratigraphic interpretation based on the evolutionary changes of Trilobites, Graptolites, and Cephalopods. Stratigraphical significance of important Gondwana and Tertiary flora.

Remote Sensing Practical

Study of Aerial Photographs using pocket stereoscopes and mirror stereoscopes. Geometry of vertical and oblique photographs: Determination of scale, height, slope, vertical exaggeration and image distortion. Photo geological study of drainage pattern and elementary geomorphic features. Interpretation of geologic structures and rock types.

Course Code	Paper Title	Credits
21PGLP2	ADVANCED CRYSTALLOGRAPHY & MINERALOGY	4

Advanced Crystallography

Calculation of Crystal elements: Zone symbol, Anharmonic Ratio, Tangent Relations, Equation to a normal drawn to a crystal face. X-Ray Crystallography: Simple problems based on Bragg's Law and Powder Camera Data. **Stereographic Projection**: Plotting of stereogram of Normal classes of the crystal Systems. Application of Napier's Theorem.

Megascopic Mineralogy

Identification of rock forming minerals in hand specimen based on their megascopic properties.

Microscopic Mineralogy

A. Identification of common rock forming minerals in thin section using their optical and diagnostic properties.

B. Exercises in Optical Mineralogy:

1. Measurement of mineral dimensions in thin section using Stage Micrometer.
2. Michel – Levi Interference Chart and the utility of mica and gypsum plates and the quartz wedge in optical mineralogy.
3. Sign of Elongation of minerals.
4. Optic sign determination of Uniaxial minerals.
5. Optic sign determination of Biaxial minerals.
6. Pleochroic scheme of Anisotropic minerals.

Mineral Calculation exercises

Calculation of molecular and structural formula using analytical data of the following mineral groups: Olivine, Pyroxene, Garnet, Feldspar, Amphibole and Mica.

FIELD TRAINING PROGRAMME:

In partial fulfilment of the M.Sc. Applied Geology degree course, the students should be trained in geological mapping of structurally complex area, for a period of 1 to 2 weeks. Similarly, they should be taken on field trips for 1 – 2 weeks to various parts of India to familiarize them with economic mineral deposits and different geological formations. Field training should be followed by laboratory processing of rocks samples and ores collected during the field work. The marks for full attendance in the Field Training Programme, submission of field report, and proper display of field specimen collections is 25. There is no passing minimum for internal assessment for the practical. Full attendance in the Field Training Programme is mandatory. **Candidates who are absent for the mandatory field program will be awarded zero (0) marks. Candidates who are absent for one or more days for the mandatory field program will also be awarded zero (0) marks if they are unable to provide a factual and acceptable explanation of their absence and submit the same to the Field Coordinators and Head of Department.**

Course Code	Paper Title	Credits
21PGLP3	PETROLOGY	4

Igneous Petrology:

Megascopy & Microscopy: Megascopic and microscopic study of common and important igneous rocks with reference to texture, mineralogy, mode of occurrence, structure, and petrographically interesting features.

Igneous Rock Geochemistry: Harker's variation diagram and its petrological interpretation. Niggli's variation diagram and its petrological interpretation. Addition & subtraction variation diagrams and their petrological interpretation. CIPW norm calculation and calculation of normative mineral and relevant oxide based petrological parameters. Preparation and interpretation of mantle and chondrite normalized spider plots using REE and ICE data of igneous rocks. Simple problems in trace element modelling.

Metamorphic Petrology

Megascopy & Microscopy: Megascopic and microscopic study of common and important metamorphic rocks with reference to texture, mineralogy, mode of occurrence, structure, and petrographically interesting features.

Metamorphic Rock Geochemistry: Calculation of parameters and graphical representation of data on ACF, AKF, and AFM diagrams coming under selected contact and regional metamorphic facies.

Sedimentary Petrology & Sedimentology

Megascopy & Microscopy: Megascopic and microscopic study of common and important sedimentary rocks with reference to texture, mineralogy, mode of occurrence, structure, and petrographically interesting features.

Mechanical analysis of sediments, calculation of sedimentological parameters, their graphical representation and interpretation. Exercises related to analyses and interpretation of depositional environments.

Course Code	Paper Title	Credits
21PGLP4	HYDROGEOLOGY & MINING GEOLOGY	4

Hydrogeology: hydro-geochemistry: determination of ph, specific conductivity (ec), total dissolved solids (tds), hardness of water - titration method. Estimation of Na, K, Ca, Mg, CO_3, HCO_3, Cl, SO_4. Methods of representation of water quality data: vertical bar graphs, vector diagram, pattern diagram, circular diagram, and USSL classification.

Hydrology: Calculation of average depth of rainfall by Theissen Method. Preparation of Isohyetal Maps. Estimation of potential evapotranspiration by using Thornwaite equation. Construction of Hydrographs and separation of different components.

Morphometric analysis: Drainage density, Stream frequency, Bifurcation ratio, Ruggedness number, Water budget calculation.

Mining geology: diagrammatic representation of open cast and underground mines. Estimation of ore reserves. Evaluation of ore bodies.

FIELD TRAINING PROGRAMME:

In partial fulfilment of the M.Sc. Applied Geology degree course, the students should be trained in geological mapping of structurally complex area, for a period of 1 to 2 weeks. Similarly, they should be taken on field trips for 1 – 2 weeks to various parts of India to familiarize them with economic mineral deposits and different geological formations. Field training should be followed by laboratory processing of rocks samples and ores collected during the field work. The marks for full attendance in the Field Training Programme, submission of field report, and proper display of field specimen collections is 25. There is no passing minimum for internal assessment for the practical. Full attendance in the Field Training Programme is mandatory. **Candidates who are absent for the mandatory field program will be awarded zero (0) marks. Candidates who are absent for one or more days for the mandatory field program will also be awarded zero (0) marks if they are unable to provide a factual and acceptable explanation of their absence and submit the same to the Field Coordinators and Head of Department.**

Course Code	Paper Title	Lectures	Tutorials	Practical	Credits
21PCHGL	GEOCHEMISTRY	1	1	-	2

Broad Objectives:

This interdisciplinary course will introduce the scope and application of industrial chemistry and geochemistry to post graduate students of Chemistry and Applied Geology. The topics covered under geochemistry includes those relevant to basic and applied aspects of geochemistry. The topics have been chosen to connect the two courses as mutually inclusive.

Learning outcomes:

The common learning outcome is that the student gains insight and useful application of both industrial chemistry which covers the analytical parts of earth materials such as soil, water, and others complemented by basic geochemistry topics which attempt to explain the causes and reasons for the distribution of elements in different earth materials in the macro scale via geochemical cycles and micro scale, within minerals.

Unit I

Water analysis: hardness, temporary hardness, permanent hardness. Determination of hardness of water, acidity, alkalinity, pH value, fluoride and chloride content. Total dissolved solids (TDS), Dissolved oxygen (DO), Biological oxygen demand (BOD), Chemical oxygen demand (COD). Recycling of water.

Unit II

Soil chemistry: definition of soils; Classification of soils; Properties of soils – physical properties and mechanical analyses. Structure and texture of soils. Soil air, soil water, and soil temperature. Chemical properties – soil – mineral and matter soil colloids; ion exchange reactions; Soil fertility and evolution. Soil erosion: causes, processes, types, estimation of soil loss; Wind erosion and soil loss; Soil conservation practices.

Unit III

Petroleum: Origin, refining, cracking, reforming, and octane number. LPG, synthetic gas, synthetic petrol. Fuel gases. Large scale production, storage, hazards, and uses of coal gas, water gas, producer gas and oil. Definition and scope of Geochemistry. Outline of elemental abundance in meteorites and different earth materials.

Unit IV

Geochemical classification of elements and reservoirs. Basic crystal chemistry: Minerals as ionic solids – bonding: types and general rules of bonding in minerals – ionization potential – electronegativity.

Unit V

Types of silicate structures. Principles of ionic substitution. Mineral isomorphism – polymorphism – pseudo-morphisms. Geochemical cycles and dispersion of elements: Primary and Secondary. Controls of dispersion: Physical and Chemical controls. Mobility of elements.

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