॥ सा विद्या या विमुक्तये ॥

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

'ज्ञानतीर्थ', विष्णुपुरी, नांदेड – ४३१ ६०६ (महाराष्ट्र राज्य) भारत

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

'Dnyanteerth', Vishnupuri, Nanded - 431 606 (Maharashtra State) INDIA

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

Established on 17th September, 1994, Recognized By the UGC U/s 2(f) and 12(B), NAAC Re-accredited with 'B++' grade

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शैक्षणिक वर्ष २०२३–२४ पासून राष्ट्रीय शैक्षणिक धोरणानुसार लागू केलेल्या विज्ञान व तंत्रज्ञान विद्याशाखेतील पद्व्युत्तर प्रथम वर्षाच्या सुधारित (दुरूस्ती) अभ्यासक्रम बाबत.

प रि प त्र क

संदर्भ:शै–१/एनईपी२०२०/S&T/अक/२०२३–२४/१३० दि.३०.०६.२०२३

या परिपत्रकान्वये सर्व संबंधीतांना कळविण्यात येते की, संदर्भीय परिपत्रकान्वये दिनांक १६ जून २०२३ रोजी संपन्न झालेल्या बैठकीतील ऐनवेळचा विषय क्रमांक ०५/५६–२०२३ अन्वये मान्यता दिल्यानुसार विज्ञान व तंत्रज्ञान विद्याशाखे अंतर्गत राष्ट्रीय शैक्षणिक धोरणानुसार पद्व्युत्तर प्रथम वर्षाचे अभ्यासक्रम २०२३–२४ पासून लागू करण्यात आलेले होते.

तथापि वरील संदर्भीय परिपत्रकान्वये प्रकाशित केलेल्या अभ्यासक्रमामध्ये अभ्यासमंडळ अध्यक्षांनी किरकोळ दुरूस्ती करून अभ्यासक्रम सादर केला आहे. त्यानुसार खालील प्रमाणे दुरूस्ती केलेले अभ्यासक्रम लागू करण्यात येत आहे.

M.sc. I Year Geology

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या **www.srtmun.ac.in** या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी, ही विनंती.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
जा.क्र.:शै–१/एनईपी/परिपत्रक/पीजी/२०२५–२६/261
दिनांक : ०८.११.२०२५

सहा.कुलसचिव
शैक्षणिक (१–अभ्यासमंडळे) विभाग

प्रत : १) मा. कुलगुरू महोदयांचे कार्यालय, प्रस्तुत विद्यापीठ.
२) मा. प्र. कुलगुरू महोदयांचे कार्यालय, प्रस्तुत विद्यापीठ.
३) मा. आधिष्ठाता, विज्ञान व तंत्रज्ञान विद्याशाखा, प्रस्तुत विद्यापीठ.
४) मा. संचालक, परीक्षा व मुंल्यमापन मंडळ, प्रस्तुत विद्यापीठ.
५) मा. प्राचार्य, सर्व संबंधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.
६) सिस्टीम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ. यांना देवून कळविण्यात येते की, सदर परिपत्रक संकेतस्थळावर प्रसिध्द करण्यात यावे.

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED - 431 606

(R-2023)

स्वामी रामानंद तीर्थ
मराठवाडा विद्यापीठ, नांदेड.

TWO YEAR MASTERS PROGRAMME IN SCIENCE

Subject - **Geology**

(Campus School)

Under the Faculty of
Science and Technology

From the Desk of the Dean, Faculty of Science and Technology

Swami Ramanand Teerth Marathwada University, Nanded, enduring to its vision statement "***Enlightened Student: A Source of Immense Power",*** is trying hard consistently to enrich the quality of science education in its jurisdiction by implementing several quality initiatives. Revision and updating curriculum to meet the standard of the courses at national and international level, implementing innovative methods of teaching-learning, improvisation in the examination and evaluation processes are some of the important measures that enabled the University to achieve the **3Es, the *equity, the efficiency and the excellence*** in higher education of this region. To overcome the difficulty of comparing the performances of the graduating students and also to provide mobility to them to join other institutions the University has adopted the *cumulative grade point average* (CGPA) system in the year 2014-2015. Further, following the suggestions by the UGC and looking at the better employability, entrepreneurship possibilities and to enhance the latent skills of the stakeholders the University has adopted the *Choice Based Credit System* (CBCS) in the year 2018-2019 at graduate and post-graduate level. This provided flexibility to the students to choose courses of their own interests. To encourage the students to opt the world-class courses offered on the online platforms like, NPTEL, SWAYM, and other MOOCS platforms the University has implemented the credit transfer policy approved by its Academic Council and also has made a provision of reimbursing registration fees of the successful students completing such courses.

SRTM University has been producing a good number of high caliber graduates; however, it is necessary to ensure that our aspiring students are able to pursue the right education. Like the engineering students, the youngsters pursuing science education need to be equipped and trained as per the requirements of the R&D institutes and industries. This would become possible only when the students undergo studies with an updated and evolving curriculum to match global scenario.

Higher education is a dynamic process and in the present era the stakeholders need to be educated and trained in view of the self-employment and self-sustaining skills like start-ups. Revision of the curriculum alone is not the measure for bringing reforms in the higher education, but invite several other initiatives. Establishing industry-institute linkages and initiating internship, on job training for the graduates in reputed industries are some of the important steps that the University would like to take in the coming time. As a result, revision of the curriculum was the need of the hour and such an opportunity was provided by the New Education Policy 2020. National Education Policy 2020 (NEP 2020) aims at equipping students with knowledge, skills, values, leadership qualities and initiates them for lifelong learning. As a result the students will acquire expertise in specialized areas of interest, kindle their intellectual curiosity and scientific temper, and create imaginative individuals.

The curriculum given in this document has been developed following the guidelines of NEP-2020 and is crucial as well as challenging due to the reason that it is a transition from general science- based to the discipline-specific-based curriculum. All the recommendations of the ***Sukanu Samiti*** given

in the **NEP Curriculum Framework-2023** have been followed, keeping the disciplinary approach with rigor and depth, appropriate to the comprehension level of learners. All the Board of Studies (BoS) under the Faculty of Science and Technology of this university have put in their tremendous efforts in making this curriculum of international standard. They have taken care of maintaining logical sequencing of the subject matter with proper placement of concepts with their linkages for better understanding of the students. We take this opportunity to congratulate the Chairman(s) and all the members of various Boards of Studies for their immense contributions in preparing the revised curriculum for the benefits of the stakeholders in line with the guidelines of the Government of Maharashtra regarding NEP-2020. We also acknowledge the suggestions and contributions of the academic and industry experts of various disciplines.

We are sure that the adoption of the revised curriculum will be advantageous for the students to enhance their skills and employability. Introduction of the mandatory ***On Job Training, Internship*** program for science background students is praise worthy and certainly help the students to imbibe first-hand work experience, team work management. These initiatives will also help the students to inculcate the workmanship spirit and explore the possibilities of setting up of their own enterprises.

Dr. L. M. Waghmare, ***Dean,*** *Faculty of Science and Technology*
Dr. M. K. Patil, ***Associate Dean,*** *Faculty of Science and Technology*

From Desk of Chairman, Board of Studies of the Subject Geology

Preamble:

Syllabus of M.Sc. Geology program offered by the School of Earth Sciences has been prepared as per the Credit Framework guidelines of National Education Policy (NEP) 2020 and considering the syllabi of the UPSC Geologists examination, MPSC examination, CSIR-NET examination and the requirements of the industry. The M.Sc. program in Geology is imparted to the students for two academic years consisting of four semesters. Candidates will be examined and evaluated on grade basis at the end of each semester in different theory and practical papers as per the credits offered by each course.

The M.Sc. Geology program consists of Core Courses, Electives Courses, Research Methodology, Publication Ethics and On Job Training. This two year program is of total 88 credits, with 22 credits for each semester. The program includes Core and Elective Courses. Students can choose one Elective Course per semester from the list of Elective Courses provided. Students are also encouraged to select Open Elective courses from National Educational Platforms such as MOOCS/NPTL/SWAYAM. If a student wishes, he/she can take a few extra courses, which will be considered as add-on credits.

In addition to class-room teaching and laboratory, the M.Sc. Geology program offers geological field training to the students. After completion of field training, students have to submit a filed report to the School. Intensive On Job Training /Internships in the nationally reputed institutes shall also be provided to the M.Sc. Geology students. The semester breaks can also be utilized for the geological field training and internships.

Students will be assessed through Continuous Assessment (CA) and End Semester Assessment (ESA). Mode of Continuous Assessment (CA) will form 20% of the Maximum Marks and will be carried out throughout the semester. It may be done by conducting Two Tests (Test I on 40% curriculum) and Test II (remaining 40% syllabus). Average of the marks scored by a student in these two tests of the theory paper will make his CA score. The End Semester Assessment (ESA) (80% of the Maximum Marks) will be based on paper-pen pattern and laboratory experiments/calculations.

Every M.Sc. Geology student has to mandatorily submit dissertation thesis. The Research Project/Dissertation is of 10 Credits, 4 Credits are in third semester and 6 credits are in fourth semester. The dissertation work is based on either new data generated for the proposed scientific problem *OR* based on available large global data sets using innovative ideas. The thesis should be based on sound methodology and well defined objectives. Through dissertation work the student should be well-versed with the literature on the chosen topic, independently define a scientific problem, carry out focused study on a research topic, analyze and interpret large data sets, independently write thesis / project proposal and present and defend the dissertation work. The Dissertation must be submitted by the end of fourth Semester with a Seminar presentation in the presence of faculty members, students and external examiners for the purpose of evaluation. The School of Earth Sciences strongly encourages the M.Sc. Geology students to publish their dissertation work in SCI journals.

Prof. Dr. Dipak Baburao Panaskar
Chairman, Board of Studies of the subject, Swami Ramanand Teerth Marathwada University, Nanded

Details of the Board of Studies Members in Geology under the faculty of Science & Technology of S.R.T.M. University, Nanded

Sr No	*Name of the Member*	*Designation*	*Address*	*Contact No.*
1	*Dr. Dipak Baburao Panaskar*	*Senior Professor*	*School of Earth Sciences, S. R. T. M. University, Nanded*	*9403227259*
2	*Dr. Hari Shankarrao Patode,*	*Associate Professor*	*School of Earth Sciences, S. R. T. M. University, Nanded*	**9850209045**
3	*Dr. Shaikh MD Babar,*	*Professor*	**DSM 's College of Arts, Commerce and Science College, Parbhani**	**9890184699**
4	*Dr. Bhagwan Balasaheb Ghute,*	*Assistant Professor*	**Toshniwal Arts, Commerce & Science College, Sengaon, Tq. Sengaon, Dist Hingoli.**	**9130006333**
5	*Dr. Udaykumar Laxmikant Sahu,*	*Assistant Professor*	**Toshniwal Arts, Commerce & Science College, Sengaon, Tq. Sengaon, Dist Hingoli.**	**9860406757**
6	*Prof. D. C. Meshram*	*Professor*	**Department of Geology, S. P. Pune University, Pune**	**8275697166**
7	*Dr. A. N. Dongre*	*Associate Professor*	**Department of Geology, S. P. Pune University, Pune**	**9922410132**
8	*Dr. Sukanta Roy*	*Principal Scientist (F) & Project Director*	**BGRL, Ministry of Earth Sciences, Karad**	**9490469980**
9	*Prof. A. R. Kulkarni*	*Professor*	**SIBER, Kolhapur**	**7588470146**

Swami Ramanand Teerth Marathwada University, Nanded

Faculty of Science & Technology

Credit Framework for Two Year PG Program

Subject: Geology

Year & Level 1	Sem. 2	Major Subject (DSC) 3	Major Subject (DSE) 4	RM 5	OJT / FP 6	Research Project 7	Practicals 8	Credits 9	Total Credits 10
1	1	SGLGCT2401 Mineralogy (4 Cr) Theory SGLGCT2402 Structural Geology and Geotectonics (4 Cr) Theory SGLGCT2403 Palaeontology and Stratigraphy (4 Cr) Theory	SGLGET2401 Geochemistry (3 Cr) Theory SGLGEP2401 Geochemistry (1 Cr) Practical	**SGLGRM2401** *Research Methodology* **(3 Cr)**	--		SGLGCP2401 Mineralogy (1 Cr) Practical SGLGCP2402 Structural Geology and Geotectonics (1 Cr) Practical SGLGCP2403 Palaeontology and Stratigraphy (1 Cr) Practical	**22**	**44**
	2	SGLGCT2451 Igneous Petrology and Sedimentary Petrology (4 Cr) Theory SGLGCT2452 Thermodynamics and Metamorphic Petrology (4 Cr) Theory SGLGCT2453 Environmental Geology (4 Cr) Theory	SGLGET2451 Computer Applications in Geology (3 Cr) Theory SGLGEP2451 Computer Applications in Geology (1 Cr) Practical **OR** SGLGET2452 Geomorphology and Morphotectonics (3 Cr) Theory SGLGEP2452 Geomorphology and Morphotectonics (1 Cr) Practical	---	**SGLGOJ2451** **(3 Cr)**	--	SGLGCP2451 Igneous Petrology and Sedimentary Petrology (1Cr) Practical SGLGCP2452 Thermodynamics and Metamorphic Petrology (1 Cr) Practical SGLGCP2453 Environmental Geology (1 Cr) Practical	**22**	
Exit option: Exit Option with PG Diploma *(after 2024-25)*									

2	**3**	SGLGCT2501 Economic Geology and Geology of Indian Mineral Deposits (4 Cr) Theory SGLGCT2502 Hydrogeology (4 Cr) Theory SGLGCT2503 Remote Sensing and Geographical Information System (4 Cr) Theory	SGLGET2501 Principles of Geophysics (2 Cr) Theory SGLGEP2501 Principles of Geophysics (1 Cr) Practical **OR** SGLGET2502 Engineering Geology (2 Cr) Theory SGLGEP2502 Engineering Geology (1 Cr) Practical ***(From same Department / School)***	--		**SGLGRP2501** **(4Cr)** Research Project	SGLGCP2501 Economic Geology and Geology of Indian Mineral Deposits (1 Cr) Practical SGLGCP2502 Hydrogeology (1 Cr) Practical SGLGCP2503 Remote Sensing and Geographical Information System (1 Cr) Practical	**22**	**44**
	4	SGLGCT2551 Coal and Petroleum Geology (4 Cr) Theory SGLGCT2552 Geoexploration, Mining Geology and Mineral Economics (4 Cr) Theory	SGLGET2551 Disaster Management (3 Cr) Theory SGLGEP2551 Disaster Management (1 Cr) Practical ***(From same Department / School)***	**SGLGPE2551** Publication Ethics (2 Cr)		**SGLGRP2551** **(6 Cr)** Research Project	SGLGCP2551 Coal and Petroleum Geology (1 Cr) Practical SGLGCP2552 Geoexploration, Mining Geology and Mineral Economics (1 Cr) Practical	**22**	
Total Credits		**44**	**15**	**05**	**03**	**10**	**11**	**88**	

M. Sc. First Year Semester I *(Level 6.0)*

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	**SGLGCT2401**	Mineralogy	04	--	**04**	04	--
	SGLGCT2402	Structural Geology and Geotectonics	04	--	**04**	04	--
	SGLGCT2403	Palaeontology and Stratigraphy	04	--	**04**	04	--
Elective (DSE)	**SGLGET2401**	Geochemistry	03	--	**03**	03	--
Research Methodology	**SGLGRM2401**	Research Methodology	03	--	**03**	03	
DSC Practical	**SGLGCP2401**	Mineralogy	--	01	**01**	--	01
	SGLGCP2402	Structural Geology and Geotectonics	--	01	**01**	--	01
	SGLGCP2403	Palaeontology and Stratigraphy	--	01	**01**	--	01
DSE Practical	**SGLGEP2401**	Geochemistry	--	01	**01**	--	01
Total Credits			**18**	**04**	**22**	**18**	**04**

M. Sc. First Year Semester I *(Level 6.0)*

Examination Scheme

[40% Continuous Assessment (***CA***) and 60% End Semester Assessment (***ESA***)]

Subjects (1)	**Course Code** (2)	**Course Name** (3)	**Theory**					Practical		**Total** Marks **(a + b)**
			Continuous Assessment (CA)					CA	ESA	
			Class Test Marks	Assignment Marks	Attendance Marks <60%=00 >60but < 75=4,2,3 >75 but < 85= 6,3,5 > 85 %= 8,4,6	Total Marks (a)	**ESA** Marks (b)	Marks	Marks	
Major DSC	SGLGCT2401	Mineralogy (4 Cr) Theory	20	12	08	40	60	...		100
	SGLGCT2402	Structural Geology and Geotectonics (4 Cr) Theory	20	12	08	40	60	...		100
	SGLGCT2403	Palaeontology and Stratigraphy (4 Cr) Theory	20	12	08	40	60	...		100
Elective DSE	SGLGET2401	Geochemistry (3 Cr) Theory	15	09	06	30	45	...		75
Research Methodology	SGLGRM2401	Research Methodology (3 Cr) Theory	15	09	06	30	45	...		75
DSE Practical's	SGLGCP2401	Mineralogy (1 Cr) Practical	...	...	...	...	...	10	15	25
	SGLGCP2402	Structural Geology and Geotectonics (1 Cr) Practical	...	...	...	...	...	10	15	25
	SGLGCP2403	Palaeontology and Stratigraphy (1 Cr) Practical	...	...	...	...	...	10	15	25
DSE Practical's	SGLGEP2401	Geochemistry (1 Cr) Practical	...	...	...	...	...	10	15	25

M. Sc. First Year Semester II *(Level 6.0)*

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	**SGLGCT2451**	Igneous Petrology and Sedimentary Petrology	04	--	**04**	04	--
	SGLGCT2452	Thermodynamics and Metamorphic Petrology	04	--	**04**	04	--
	SGLGCT2453	Environmental Geology	04	--	**04**	04	--
Elective (DSE)	**SGLGET2451 OR SGLGET2452**	Computer Applications in Geology OR Geomorphology and Morphotectonics	03	--	**03**	03	--
On Job Training	**SGLGOJ2451**	ON Job Training	03	--	**03**	03	
DSC Practical	**SGLGCP2451**	Igneous Petrology and Sedimentary Petrology	--	01	**01**	--	02
	SGLGCP2452	Thermodynamics and Metamorphic Petrology	--	01	**01**	--	02
	SGLGCP2453	Environmental Geology	--	01	**01**	--	02
DSE Practical	**SGLGEP2451 OR SGLGEP2452**	Computer Applications in Geology OR Geomorphology and Morphotectonics	--	01	**01**	--	02
Total Credits			**18**	**04**	**22**	**14**	**08**

M. Sc. First Year Semester II *(Level 6.0)*

Examination Scheme

[20% Continuous Assessment (***CA***) and 80% End Semester Assessment (***ESA***)]

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical		Total Col (6+7) / Col (8+9) (10)
			Continuous Assessment (CA)			ESA			
			Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)	Total (7)	CA (8)	ESA (9)	
Major	**SGLGCT2451**	Igneous Petrology and Sedimentary Petrology	20	20	20	80	--	--	100
	SGLGCT2452	Thermodynamics and Metamorphic Petrology	20	20	20	80	--	--	100
	SGLGCT2453	Environmental Geology	20	20	20	80	--	--	100
Elective (DSE)	**SGLGET2451 OR SGLGET2452**	Computer Applications in Geology OR Geomorphology and Morphotectonics	15	15	15	60	--	--	75
On Job Training	**SGLGOJ2451**	ON Job Training	15	15	15	60	--	--	75
DSE Practical	**SGLGCP2451**	Igneous Petrology and Sedimentary Petrology	--	--	--	--	05	20	25
	SGLGCP2452	Thermodynamics and Metamorphic Petrology	--	--	--	--	05	20	25
	SGLGCP2453	Environmental Geology	--	--	--	--	05	20	25
DSE Practical	**SGLGEP2451 OR SGLGEP2452**	Computer Applications in Geology OR Geomorphology and Morphotectonics	--	--	--	--	05	20	25

SGLGCT2401: Mineralogy *(4 Cr) Curriculum Details*

Course pre-requisite:

1. Basic (10+2) knowledge of chemistry and physics + good observational skills

Course objectives:

1. Minerals are the fundamental blocks of all Earth's solid material and also that of the inner planets of our Solar system. Mineralogy is essential for the courses in igneous, sedimentary and metamorphic petrology, economic geology and for interpretation of geophysical data.
2. This course in Mineralogy would help the students to understand distribution of minerals in different Earth's spheres, evaluate different processes of mineral formation, why some minerals are restricted to particular physic-chemical environments, identify and characterize the minerals based on their physical, crystal chemical and optical properties.
3. The student will study the basic principles behind the arrangement of atoms to form crystal structures, how these atoms are coordinated and bonded and how this is reflected in the external form, chemical composition, and physical properties of the crystals.
4. The student will study how to identify the most common minerals in hand specimen and, by using optical techniques, learn how to identify the common minerals in thin section.
5. The course introduces the minerals, which are of economic significance. The course also introduces the student to sophisticated instruments used in deciphering mineral structure and chemistry.

Course outcomes:

At the completion of the course students would be able to

1. Explain why different minerals have distinctly different structures.
2. Explain distribution of elements in different structural sites of the minerals.
3. Explain how the properties of chemical elements and their bonds determine the structure and composition of minerals.
4. Demonstrate how the internal structure of minerals affects the external structure and physical properties of minerals
5. Explain the mineralogical concepts of isomorphism, polymorphism, isostructuralism, solid solution and exsolution.
6. Discuss which mineral identification method is appropriate for solving a mineralogical problem (e.g. polarizing microscope, x-ray diffraction, electron microprobe).
7. Recognize and describe the basic properties and chemistry of common rock-forming minerals.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Introduction and Scope**	**15**
	1.1	Mineralogy and its scope.	
	1.2	Classification of Minerals.	
	1.3	Processes of Mineral formation.	
2.0		**Physical Properties of Minerals**	**15**
	2.1	Properties under light	
	2.2	Electrical properties.	
	2.3	Magnetic properties.	
	2.4	Radioactive properties.	
3.0		**Chemistry and Structure of Minerals**	**15**
	3.1	Basic properties of Elements, Chemical and Geochemical Classification of Elements.	
	3.2	Solid solution, Exsolution, Pauling's Rules, Goldschmidt's Rules, Principles and use of EPMA & ICP-MS in Mineralogical Studies.	
	3.3	Silicate Structures.	
	3.4	Polymorphism, Pseudomorphism.	
4.0		**Optical Properties of Minerals & Descriptive Mineralogy**	**15**
	4.1	Basic introduction to wave propagation.	
	4.2	Isotropy and Anisotropy of Minerals, Petrological Microscope, Optical indicatrices, Orthoscopic properties, Conoscopic properties.	
	4.3	Silicates, Oxides, Carbonates, Sulphides.	
	4.4	Precious and Semi-precious stones.	
		Total	**60**

SGLGCP2401 Mineralogy (1 Cr) Practical

1. Study of Rock-forming minerals in Hand Specimen.
2. Study of Rock-forming minerals in Thin Section.
3. Conoscopic Observations of minerals.
4. Calculation of Mineral Chemical Formulae

Text Books and Reference Books:

- *An Introduction to the Rock-Forming Minerals by W.A. Deer, R.A. Howie and J. Zussman (Descriptive Mineralogy)
- *Crystallography by Walter Borchardt-Ott (X-Ray Diffraction and Crystal Chemistry)
- *Manual of Mineralogy by C. Klein and C.S. Hurlbut (Prescribed Text Book)
- *Rutley's Elements of Mineralogy by C.D. Gribble (An Elementary text Book)
- An introduction to Mineralogy for Geologists by Phillips and Phillips (Crystallography, Crystal Chemistry & Silicate Structures)
- Dana's New Mineralogy by Gaines, Skinner, Ford, Mason, Rosenzneig (Descriptive Mineralogy)
- Heavy Minerals in Colour by Mange and Maurer (Good Photographs & brief description of Heavy Minerals)
- Introduction to Mineralogy by William D Nesse
- Mineralogy by Berry Mason and Dietrich (Descriptive Mineralogy)
- Mineralogy by Perkins
- Minerals by G.W. Robinson (Good Photographs of Minerals)
- Optical Mineralogy by Paul F. Kerr
- Optical Mineralogy by P.R.J. Naidu
- Optical Mineralogy by Phillips and Griffen (Optical Mineralogy)
- Principles of Crystal Chemistry by E. Cartmell (Crystal Chemistry)
- Principles of Mineralogy by Blackburn and Denner (X-Ray Crystallography & Descriptive Mineralogy)
- Rock and Minerals by Dougel Dixon (Good Photographs)
- Rock-forming Minerals in Thin Section by H. Pichler and C. Schmitt-Riegraf (Thin Section Photographs)
- Rocks and Minerals by Basil Booth (Good Photographs)
- Rocks and Minerals by Chris Pellant (Good Photographs)
- The Illustrated Encyclopedia of Minerals and Rocks by J. Kourimsky (Good Photographs)
- Lecture hand-outs
    - Research papers

SGLGCT2402: Structural Geology and Geotectonics *(4 Cr)*

Pre-requisites:

Basic (10+2) knowledge of minerals and rocks. The course consists of field work on holidays; wherein student has to work independently. The field tour is a compulsory component of the course.

Course objectives:

1. To interpret the data and identify the structural features.
2. To train the students in identification of structural features, measurement of field data from the structures in the field, plotting and interpreting the data.
3. To train the students in understanding the mechanics of deformations.
4. Measurement of various orientation data from the structures, plotting them in suitable diagrams and make a quantitative analysis.
5. To develop the writing skills based on research pattern/report writing which is useful in research institutes, Government and private organizations.
6. To develop the skills of individual student so that he/she will be competent enough to get job in this field of specialization.

Course outcomes:

Students who earn minimum grade should be able to

1. Interpret the field data and interpret structures and deformations.
2. Identify and describe the structures at macroscopic, mesoscopic and microscopic level using specific nomenclature.
3. Understand and describe geometric features formed in the naturally deformed rocks and interpret the type of stress that developed the structure(s).
4. Portray 3D structures on map using different field data.
5. Work individually in the field and produce structural map of a region.
6. Explain the structural features of the region and thereby the geological history of the region.
7. Develop writing skills in writing home assignment, report etc which will be useful in research institutes/govt. organisations/pvt organizations.
8. Understand the methodology of carrying out scientific research in the field of structural geology and geotectonics.
9. Present his/her research findings in the seminars/conferences etc. or publish the research papers at national and international level

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Stress-strain analysis**	**15**
	1.1	Stress-strain relationships for elastic, plastic and viscous materials; measurement of strain in deformed rocks; Mohr's circle and criteria for failure of rocks; ductile and brittle shears in rocks; kinematic and dynamic analysis of deformation; measurement of strain in deformed rocks.	
	1.2	Structural analysis of fold, cleavage, boudin, lineation, joint, and fault; stereographic projection of linear and planar structures; calculation of paleostress. Time relationship between crystallization and deformation.	
	1.3	Various states of stresses and their representation by Mohr circles. Techniques of strain analysis, Role of fluids in deformation processes	
	1.4	Rock fabrics- origin, significance, metamorphic tectonites, petrofabrics at microscopic level; use of stereographic and equal area projections.	
2.0		**Linear structures – Joints**	**15**
	2.1	Tectonic and non-tectonic joints, columnar and release joints, joint initiation and its mechanics.	
	2.2	Rock cleavages-axial plane cleavages, their significance, mechanics of rock cleavages.	
	2.3	Foliations and lineations; boudinage-types and significance; shear zones: types of shear zones; brittle-ductile and ductile structures in shear zones and their kinematic significance.	
	2.4	Shear zone rocks-mylonite, breccias, etc; planar and linear fabrics in deformed rocks-origin and importance.	
3.0		**Structural Features: Folds and Faults**	**15**
	3.1	Types and classification of Folds and Faults.	
	3.2	Identification of Folds and Faults in the field.	
	3.3	Mechanism of formation of Folds, Faults, Unconformities.	
	3.4	Application of structural features in other branches.	
4.0		**Geotectonics**	**15**
	4.1	Continents and Oceans: features & origin; Werner's concept of Continental Drift; Wilson cycle	
	4.2	Concept of plate, types of plates, plate driving forces, regional tectonic features: ridges, arcs and subduction zone with special reference to Indian examples, hot spots.	
	4.3	Plate collisions: types, products; tectonics of India with special reference to Himalaya plate convergence.	
	4.4	Indian continental deformation; structures at macroscopic level; deformation pattern and magma associations and associated economically important deposits.	
		Total	**60**

SGLGCP2402 Structural Geology and Geotectonics (1 Cr) Practical

1. Importance of contour diagrams, investigation and interpretation of geological maps.
2. Stereographic analysis of structural data.
3. Structural problems related to borehole data.
4. Stress-strain analyses.
5. Strain ellipsoids and their significance.
6. Analysing deformations at microscopic level and mesoscopic level.
7. Identification and interpretation of deformations in Deccan Trap and Eastern Dharwar Craton

Text Books and Reference Books:

- **An Introduction to Structural Geology** by **A.K. Jain (Geological Society of India publication)**
- **An outline of Structural Geology** by **B.E. Hobbs, W.D. Means and P.F. Williams**
- **Analysis of Geological Structures** by **N.J. Price and J.W. Cosgrove**
- **Aspects of Tectonics -Focus on south central Asia** by **K.S. Valdiya**
- **Basic methods of Structural Geology** by **S. Marshak and G. Mitra**
- **Dynamic Himalaya by K.S. Valdiya**
- **Folding and fracturing of rocks** by **J.G. Ramsay**
- **Geological Structures of SEDVP** by **R.D. Kaplay, Md. Babar, P.R. Wesanekar and T. Vijay Kumar**
- **Geology, Vol. I, Strain Analysis, Academic Press.**
- **Geology, Vol. II, Folds and Fractures, Academic Press.**
- **Geology, Vol. III (Application of continuum mechanics), Academic Press.**
- **Geotectonics by V. V. Beloussov**
- **Global Tectonics. Third Edition (Reprint)** by **P. Keary, K.A. Klepeis and F.J. Vine**
- **Mapping of Geological Structures** by **K. McClay**
- **Mechanics in Structural Geology** by **B. Bayly**
- **Microtectonics** by **C.W. Passchier and R.A.J. Trouw**
- **Our Evolving Planet: Earths History in New Tectonics** by **K.N. Storetvedt**
- **Plate Tectonics and Crustal Evolution, 3rd Ed.** by **K.C. Condie**
- **Structural analysis of Metamorphic tectonites by F.J. Turner and L.E. Weiss**
- **Structural Geology** by **Marland P. Billings**
- **Structural Geology** by **H. Fossen (highly recommended)**
- **Structural Geology of Rocks and Region** by **G.R. Davis**
- **Structural Geology of Rocks and Regions** by **G.H. Davis and S.J. Reynolds**
- **Structural Geology: Fundamental and Modern** by **S.K. Ghosh**

- **Structure and Tectonics** by **P.C. Badgley**
- **Techniques of Modern Structural Geology: Folds and Fractures** by **J.G. Ramsay and M.I. Huber**
- **Tectonics and Structural Geology: Indian Context** by **Soumyajit Mukherjee**
- **Tectonics** by **Eldridge M. Moores and Robert J. Twiss**
- **The Dynamic Earth System** by **A.M. Patwardhan**
- **The Evolving Continents** by **B.F. Windley**

Understanding the Earth by **I.G. Gass**

SGLGCT2403: Palaeontology and Stratigraphy *(4Cr)*

Pre-requisites:

Basic (10+2) knowledge of biology.

Course objectives:

1. Study of paleontology with reference to animal and plant evolution.
2. Application of micropaleontology in oil industries.
3. To develop the writing skills based on research pattern/report writing which is useful in research institutes/govt. organizations/pvt.organizations.
4. To develop the skills of individual student so that he/she will be competent enough to get job in this field of specialization.
5. To understood the principles and concept of stratigraphy.
6. To train the students in identification of beds, formations, sedimentary structures, measurement of field, plotting and interpreting them.
7. To train the students to identify and correlate the formations.
8. Measurement of various orientation data from the structures, plotting them in suitable diagrams and make a quantitative analysis.
9. To develop the writing skills based on research pattern/report writing which is useful in research institutes/govt. organisations/Pvt. organizations.
10. To develop the skills of individual student so that he/she will be competent enough to get job in this field of specialization

Course outcomes:

At the completion of the course student would be able to

1. Identify fossils based on morphological observations.
2. Correlate different stratigraphic units based on fossil record.
3. Classify and characterize different fossils.
4. Better understand origin and evolution of life.
5. Better understand the Palaeo-geography of India.
9. Use microfossils in the exploration for fossil fuels.
10. Understand principles of stratigraphic correlation
11. Correlate different strata based on different tools
12. Describe the utility of sequence stratigraphy in hydrocarbon exploration
13. Understand in detail the stratigraphy of India

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Paleontology**	**15**
	1.1	General classification of fossils.	
	1.2	Evolution - evolutionary pattern based on fossil record.	
	1.3	Stratigraphic range and distribution of invertebrate, vertebrate and plant fossils Fossil record with special reference to India.	
	1.4	Significance of marker fossils and fossil assemblages in stratigraphy.	
2.0		**Micropaleontology**	**15**
	2.1	Definition and scope of Micropaleontology.	
	2.2	Use of Micropaleontology in exploration of fossil fuels Equipments for micro-paleontological studies.	
	2.3	Foraminifera and Ostracoda - their morphology, orientations, growth, reproduction.	
	2.4	Ecology and palaeo-ecology, classification, evolutionary trends and stratigraphic distribution.	
3.0		**Stratigraphy- Introduction & Methods of Stratigraphic Correlations**	**15**
	3.1	Geological Time Scale. Stratigraphy- development of concept and principles of stratigraphy.	
	3.2	Facies Concept in Stratigraphy: Walther's Law of Facies; Concept of lithofacies and biofacies, Transgressions and regression.	
	3.3	Stratigraphic correlation: litho-stratigraphy, bio-stratigraphy, chrono-stratigraphy and magneto-stratigraphy; High Resolution stratigraphic correlation methods (e.g. core and well logging, chemostratigraphy).	
	3.4	Concept of Sequence Stratigraphy; Order and duration of sequences; Application of Sequence stratigraphy in hydrocarbon exploration.	
4.0		**Stratigraphy of India**	**15**
	4.1	Stratigraphy of cratons (Dharwar, Bastar, Singhbhum, Bundhelkhand and Aravalli); Stratigraphy of mobile belts (Eastern Ghat belt, Singhbhum-Chotanagpur belt, Delhi belt Central Indian Tectonic Zone, and Southern Granulite belt).	
	4.2	Stratigraphy of Proterozoic basins (Cuddapah and Kurnool basins, Vindhyan basin, Chattisgarh basin); Precambrian/ Cambrian boundary.	
	4.3	Stratigraphy of the marine Palaeozoic rock formations of India; Permian/Triassic boundary; Stratigraphy of Indian Gondwana basins; Cretaceous/Tertiary boundary.	
	4.4	Stratigraphy of Palaeogene and Neogene systems in India; Epoch boundaries of the Cenozoic in India.	
		Total	**60**

SGLGCP2403 Palaeontology and Stratigraphy (1 Cr) Practical

1. Megascopic identification and description of invertebrate and vertebrate fossil specimens in the laboratory.

2. Collection, identification and description of different fossils from the field.

3. In Laboratory:

Study of rocks in hand specimens from known Indian stratigraphic horizons and type localities; Preparation of Stratigraphic correlation maps. Preparation of magneto-stratigraphic and chemo-stratigraphic maps and interpretations.

4. In Field:

Identification of lithofacies and biofacies in the field

- ***Text Books and Reference Books:***

- **A Concise Dictionary of Paleontology** by **R. L. Carlton**
- **An introduction to fossils and minerals** by **Jon Erickson**
- **Basic Palaeontology** by **Michael J. Benton and David A.T. Harper**
- **Dynamics of the Earth System: Evolution, Processes and Interactions (2020)** by **D. K. Pandey, (Ed), M. Ravichandran, (Ed) and N. Nair, (Ed)**
- **Elements of Micropaleontology** by **G. Bignot**
- **Fundamentals of Invertebrate Palaeontology** by **S. Jain**
- **Introduction to Marine Micropaleontology** by **Haq and Boersma**
- **Microfossils** by **M.D. Braiser**
- **Micropaleontology in Petroleum Exploration** by **R.W. Jones**
- **Micropaleontology: Principles and Applications** by **Pratul Kumar Sarswati and M.S. Srinivisan**
- **Nature through Time (2020)** by **Martinetto, E. (Ed), Tschopp, E. (Ed), Gastaldo, R. (Ed)**
- **Palaeontology (palaeobiology): Evolution and animal distribution** by **P.C. Jain and M.S. Anantharaman**
- **Principles of palaeontology** by **Stanley Raup**
- **Quaternary Environmental Micropaleontology** by **Simon K. Hasllett**
- **Vertebrate Palaeontology** by **Michael Benton**
- **A Manual of the Geology of India and Burma (Vols. I-IV)** by **E.H. Pascoe**
- **Depositional Sedimentary Environments** by **H.E. Reineck and I.B. Singh**
- **Fundamentals of historical geology and stratigraphy of India** by **G. R. Ravindra Kumar**
- **Geology of India and Burma** by **M.S. Krishnan**
- **Geology of India: Volume 1 and Volume 2** by **M. Ramakrishnan and R. Vaidyanathan**
- **Precambrian Geology of India** by **S.M. Naqvi and J.J.W. Rogers**
- **Principles of Sedimentology and Stratigraphy, (Fourth Edition)** by **Sam Boggs Jr.**
- **Principles of Sequence Stratigraphy** by **O. Catenuanu**

- **Principles of Stratigraphy** by **C.O. Danbar and J. Rodgers**
- **Seismic stratigraphy and global changes of sea level: American Association of petroleum Geologists** by **P.R. Vail, R. M. Mitchum, R. G. Todd, J. M. Widmier,**

  S. Thompson, J.B. Sangree, J.N. Bubb and W.G. Hatlelid

- **Seismic Stratigraphy- Applications to Hydrocarbon Exploration, Memoir of the American Association of Petroleum Geologists 26** by **C.E. Payton**
- **Sequence Stratigraphy** by **D. Emery and K.J. Myers**
- **Stratigraphy: Principles and Methods** by **Robert, M. Schoch**
- **The Cenozoic Era? Tertiary and Quaternary** by **C. Pomerol**
- **The Geology of Stratigraphic Sequences** by **A.D. Miall**

- **The Making of India: Geodynamic Evolution** by **K. S. Valdiya**
- **Unlocking the Stratigraphic Record** by **P. Doyle and M.R. Bennett**

SGLGET2401: Geochemistry *(3 Cr) (Elective 1)*

Pre-requisites:

Basic (10+2) knowledge of chemistry + good analytical skills

Course objectives:

1. The science of Geochemistry deals with the primordial distribution of elements in different spheres, their migration one sphere to another sphere and the rules governing the distribution and migration of elements.
2. Quantitative estimation of the distribution and migration of elements, in space and time, as the earth evolved.
3. Elements are the fundamental unit of all earth's spheres and also that of the planets of our Solar system.
4. Geochemistry is essential for the courses in igneous, sedimentary and metamorphic petrology, economic geology and for interpretation of geophysical data.
5. This course in Geochemistry would help the students to understand origin of elements, cosmic abundance of elements, what makes Earth's chemical composition unique, primary distribution of elements in different Earth's spheres, evaluate different processes of element migration and how physic-chemical conditions control elemental migration.
6. The course introduces stable and radioactive isotope geochemistry.

Course outcomes:

At the completion of the course student would be able to

1. Explain the origin of elements.
2. Explain distribution of elements in different spheres of the Earth.
3. Explain how the atomic properties of elements and their bonds determine the structure and composition of Earth's spheres.
4. Discuss the role of elements and their isotopes in evaluating Earth's processes.
5. Explain the geochemical processes controlling elemental distribution.
6. Graphical representation of element distribution.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Introduction to Origin**	**15**
	1.1	Origin of elements; Elements and the periodic table.	
	1.2	Goldschmidt's classification; Cosmic abundance of elements.	
	1.3	Structure and composition of Universe and Solar system.	
	1.4	Meteorites-types and composition.	
2.0		**Distribution of Elements**	**10**
	2.1	Primordial distribution and chemical differentiation of the Earth .	
	2.2	Thermodynamic classification of elements.	
	2.3	Nernst-Berthelot partition coefficient and bulk partition coefficient; fractionation of elements in minerals/rocks.	
	2.4	Fick's laws of diffusion and activity composition relation (Roult's and Henry's law); Geochemistry of different spheres of Earth.	
3.0		**Introduction to Isotope Geochemistry**	**10**
	3.1	Half-life and decay equation .	
	3.2	Dating of minerals and rocks with potassium-argon, rubidium-strontium isotopes.	
	3.3	Dating of minerals and rocks with uranium-lead and isotopes.	
	3.4	Dating of minerals and rocks with samarium-neodymium isotopes.	
4.0		**Introduction to Isotope Geochemistry**	**10**
	4.1	Petrogenetic implications of samarium-neodymium systems.	
	4.2	Petrogenetic implications of rubidium-strontium systems .	
	4.3	Stable isotope geochemistry of carbon, oxygen and sulphur.	
	4.4	Their applications in geology; monazite chemical dating; Geochemical Cycle .	
		Total	**45**

SGLGEP2401: Geochemistry (1 Cr) Practical

1. Graphical representation of geochemical data.
2. Practical based on Trace element geochemistry.
3. Practical based on Stable and Radiogenic Isotope geochemistry.

Text Books and Reference Books:

- **Essentials of Geochemistry (2nd Edition)** by **J. Walther**
- **Geochemistry** by **M. White**
- **Geochemistry Pathways and Processes (2nd Edition)** by **H. Y. McSween, S. M. Richardson and M. Uhle**
- **Inorganic Geochemistry - Principles and Applications (3rd Edition)** by **G. Faure**
- **Introduction to Geochemistry** by **Francis Albarede**
- **Introduction to Geochemistry - Principles and Applications** by **K. C. Misra**
- **Inorganic Geochemistry** by **Henderson**
- **Introduction to Geochemical Modeling** by **Francis Albarede**
- **Principles of Geochemistry** by **Brain Mason and Carleton B. Moore**
- **Using Geochemical Data: Evaluation, Presentation, Interpretation** by **Hugh Rollinson**

SGLGCT2451: Igeneous Petrology and Sedimentary Petrology *(4 Cr) (Major 1)*

Pre-requisites:

Basic (10+2) knowledge of chemistry and physics + completion of courses SGLGCT2401(Mineralogy) and SGLGET2401 (Geochemistry).

Course objectives:

This course in igneous petrology would help the students to understand

1. Origin of magmas in crust and mantle, evaluate different processes of magma generation
2. Role of temperature, pressure, depth and volatiles on magma composition
3. Application of thermodynamics in understanding igneous rocks
4. Evaluate the role of geochemistry in deciphering magma generation and evolution
5. Correlate magma compositions with plate boundaries.
6. Identify and characterize the igneous rocks based on their physical and textural characteristics.
7. To train the students in identification of beds, formations, sedimentary structures, measurement of field, plotting and interpreting them.
8. To train the students to identify and correlate the formations.
9. To train the students in measuring various orientation data from the structures, plotting them in suitable diagrams and make a quantitative analysis.
10. To teach geochemistry of sedimentary rocks.
11. To develop the writing skills based on research pattern/report writing which is useful in research institutes/govt. organizations/ Pvt. Organizations.
12. To develop the skills of individual student so that he/she will be competent enough to get job in this field of specialization

Course outcomes:

At the completion of the course student would be able to

1. Explain generation of different mantle reservoirs.
2. Explain origin and differentiation of magmas.
3. Apply phase equilibria to the genesis of igneous rocks.
4. Utilize geochemistry in understating igneous processes.
5. Discriminate present- and palaeo-tectonic environments of igneous rocks.
6. Describe crust-mantle differentiation in space and time.
7. Decipher relationship between petrogenesis and ore genesis.
8. Identify and characterize igneous rocks based on megascopic and microscopic observations.
9. Graphically represent geochemical variations in magmas.
10. Correlate different sedimentary strata.
11. Evaluate sedimentary environments.
12. Evaluate the geochemical variations in sedimentary rocks.
13. Understand the sedimentary rocks.
14. Carry out Palaeocurrent analysis.
15. Identify and distinguish different sedimentary rocks.

Curriculum Details:

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**Igneous Petrology and its scope, Magma Generation, Evolution and Phase Equilibria**	**15**
	1.1	From Planetary evolution to the evolution of Lithosphere, Hydrosphere and Biosphere. Major Structural Units of the Earth Pressure Distribution within the Earth Temperature Distribution within the Earth.	
	1.2	Heat Sources for Magma Generation Physical Properties of the Magma Cooling/Crystallization of Magmas. Igneous Textures Classification Igneous Rocks.	
	1.3	Sites of Magma Generation Petrology and Geochemistry of Mantle Partial Melting and types of mantle melting, Primary Melts. Magmatic differentiation, Zone melting, Contamination, Mixing of magmas Magmas and Tectonic Environments Role of Geochemistry in Igneous Petrogenesis.	
	1.4	Gibb's and Mineralogical Phase Rule, One component system, Two component system. Three component system, Four component system, Role of Volatiles on Phase Equilibria.	
2.0		**Petrogenetic Suites and Associations**	**15**
	2.1	Komatiites, Basalts	
	2.2	Anorthosites, Layered Complexes	
	2.3	Ophiolites, Lamprophyres, Lamproites, Kimberlites, Carbonatites and Alkaline Rocks.	
	2.4	Andesites and Boninites, Granites.	
3.0		**Sedimentary Rocks and Process**	**15**
	3.1	Classification of sedimentary rocks; Processes and products of sedimentation .	
	3.2	Detrital sediments; Chemical precipitates; Volcano-clastic sediments .	
	3.3	Sedimentary structures and textures; Particle size of detrital rocks: Definition, measurement, size parameters, grain size distribution and causal factors .	
	3.4	Grain size distributions and environmental analysis, Sphericity and roundness, Packing and fabric, Porosity and permeability .	
4.0		**Depositional environments**	**15**
	4.1	Depositional environments and the sedimentary products .	
	4.2	Palaeocurrents and basin analysis; Basin shape, depth and sedimentation .	
	4.3	Geochemistry of sediments and sedimentary rocks; Source and process control on composition of Sedimentary rocks .	
	4.4	Plate tectonics and sedimentary rocks .	
		Total	**60**

SGLGCP2451: Igeneous Petrology and Sedimentary Petrology (1 Cr)

Practical

1. Study of Igneous Rocks in Hand Specimen.
2. Study of Igneous Rocks in Thin Section.
3. Binary and Ternary Variation Plots.
4. Tectonic discrimination plots.
5. Rare Earth Element and Incompatible Element Normalized Plots.
6. Study of Sedimentary Rocks in Hand Specimen.
7. Study of Sedimentary Rocks in Thin Section.
8. Grain size and grain shape analysis of sediments.

Text Books and Reference Books:

- **An Evolution of Igneous Rocks** by **N. L. Bowen (***Classical text based on Experimental Petrology***)**
- **Atlas Igneous Rocks and their Textures** by **McKenzie, Donaldson and Guilford (***Excellent book on texture illustrations***)**
- **Essentials of Igneous and Metamorphic Petrology** by **B. Ronald Frost and Carol D. Frost**
- **Igneous and Metamorphic Petrology** by **Best (***Rock Associations***)**
- **Igneous and Metamorphic rocks under Microscope** by **Shelly (***Good introductory book on petrography***)**
- **Igneous Petrogenesis and Global Tectonic Environments** by **Marjorie Wilson (***Advanced Text on rock associations and tectonic environments***)**
- **Igneous Petrology** by **Anthony Hall (***Phase Equilibria***)**
- **Igneous Petrology** by **D. S. Barker (***Good general text book***)**
- **Igneous Petrology** by **McBirney (***Textures & Rocks***)**
- **Igneous Rocks** by **Gupta (***With Indian examples***)**
- **Inorganic Geochemistry** by **Henderson (***Good introductory book on Geochemistry principles***)**
- **Introduction to Geochemical Modeling** by **Francis Albarede (***Advanced book on geochemical modeling)***)**
- **Petrography** by **William, Turner and Gilbert (***Good introductory book on petrography***)**
- **Petrologic phase equilibria** by **W.G. Ernst**
- **Petrology** by **Nockolds, Knox and Chinner (***Classic introductory book***)**
- **Petrology** by **Raymond (***Good introductory book***)**
- **Petrology of Igneous Rocks** by **Hatch, Wells and Wells (***Good introductory book***)**
- **Petrology of Igneous, Sedimentary and Metamorphic Rocks** by **Ehlers and Blatt (*Good introductory book*)**
- **Phase Diagrams** by **A. R. Morse (***Good introductory book on phase equilibria***)**
- **Principles of Geochemistry** by **G. Faure (***Advanced book on Geochemistry principles***)**

- **Principles of Igneous & Metamorphic Petrology** by **A. R. Philpotts (***physical properties of Magma***)**
- **Principles of Igneous and Metamorphic Petrology** by **Anthony Philpotts and Jay Ague**
- **Principles of Igneous and Metamorphic Petrology** by **John D. Winter**
- **Principles of Igneous Petrology** by **Maaloe (*Good Theoretical text*)**

The Principles of Petrology by **G. W. Tyrrell (*Basic introductory book*)**

- **Applied Sedimentology** by **Richard C. Selly**
- **Atlas of Sedimentary Rocks Under the Microscope** by **A. E. Adams, C. Guilford, and W. S. MacKenzie**
- **Depositional Sedimentary Environments** by **H.E. Reineck and I.B. Singh**
- **Geochemistry of Sediments and Sedimentary Rocks: Evolutionary Considerations to Mineral Deposit- Forming Environments Edited** by **David Lentz**
- **Origin of sedimentary rocks** by **Harvey Blatt**
- **Petrography** by **William, Turner and Gilbert (***Good introductory book on petrography***)**
- **Petrology** by **Nockolds, Knox and Chinner (***Classic introductory book***)**
- **Petrology** by **Raymond (***Good introductory book***)**
- **Petrology of Igneous, Sedimentary and Metamorphic Rocks** by **Ehlers and Blatt (*Good introductory book*)**
- **Petrology of sedimentary rocks** by **Sam Boggs**
- **Physical Principles of Sedimentology** by **Kenneth J. Hsü**
- **Principles of Sedimentology and Stratigraphy** by **Sam Boggs**
- **Sedimentary geology** by **Donald Prothero**
- **Sedimentary Petrology: An Introduction to the Origin of Sedimentary Rocks** by **Maurice** E. **Tucker**
- **Sedimentary Provenance and Petrogenesis: Perspectives from Petrography and Geochemistry (GSA special paper)** by **José Arribas**, **Mark J. Johnsson** and **Salvatore Critelli**
- **Sedimentary Rocks** by **F.J. Pettiohn**
- **Sedimentary Rocks** by **Holly Cefrey**
- **Sedimentary Rocks** by **Rebecca Pettiford**
- **Sedimentary rocks in the field** by **Maurice Tucker**
- **Sedimentary Rocks in the Field: A Colour Guide** by **D. A. V. Stow**
- **Sedimentology and Stratigraphy** by **Gary Nichols**
- **Sedimentology** by **Michael McLane**

SGLGCT2452: Thermodynamics And Metamorphic Petrology *(4 Cr) (Major 2)*

Pre-requisites:

Basic (10+2) knowledge of chemistry and physics + completion of courses SGLGCT2401 (Mineralogy) and SGLGET2401 (Geochemistry).

Course objectives:

This course in thermodynamics and metamorphic petrology would help the students to understand

1. Application of thermodynamics to understand metamorphic processes.
2. Formation of metamorphic rocks as controlled by pressure-temperature changes in the deep Earth consequently they are the windows to deep Earth composition, structure and processes.
3. Significance of metamorphic rocks to understand crustal differentiation. Study of metamorphic rocks to evaluate crust differentiation in space and time.
4. Significance of metamorphic rocks to our understanding of vertical and horizontal tectonics of planet Earth.
5. The role of volatiles consumed and released during formation of metamorphic rocks for the continuation of plate tectonics and subduction zone magmatism and formation of many ore deposits.
6. Metamorphism as the fundamental process of altering earlier minerals and formation of new minerals stable in the changed physico-chemical conditions.

Course outcomes:

At the completion of the course student would be able to

1. Apply principles of Thermodynamics to metamorphic processes.
2. Explain elemental diffusion and formation of new minerals.
3. Explain differentiation of continental crust.
4. Discriminate present- and palaeo-tectonic environments of metamorphic rocks.
5. Identify and characterize metamorphic rocks based on megascopic and microscopic observations.
7. Graphically represent mineralogical variations in metamorphic rocks.

Curriculum Details:

Module	UnitNo.	Topic	Hrs.

No.			Required to cover the contents
1. 0		**Thermodynamics**	**15**
	1.1	System, Phase, Component and Phase Rule, Enthalpy, Entropy and Gibb's Free Energy.	
	1.2	1^{st}, 2^{nd} and 3^{rd} Laws of Thermodynamics Reaction kinetics.	
	1.3	Clausius - Clapeyron Equation and Calculation of Reaction Boundaries, Geothermobarometry.	
	1.4	Psuedosections, P-T-t Path.	
2.0		**Introduction to Metamorphism**	**15**
	2.1	Metamorphism as a process of Earth's differentiation, Metamorphic processes.	
	2.2	Role of P/T conditions and fluids in metamorphism, Deformation associated with metamorphism.	
	2.3	Migmatites and partial melting, Metamorphic structures and textures.	
	2.4	Geochemistry of metamorphic rocks.	
3.0		**Metamorphic rocks: Grades, Zones and Facies**	**15**
	3.1	Types of metamorphism and their products.	
	3.2	Metamorphic grades, Metamorphic zones.	
	3.3	Metamorphic facies concept.	
	3.4	Experimental studies on metamorphic reactions, Characteristics of important metamorphic reactions.	
4.0		**Plate tectonics ad Metamorphic rocks**	**15**
	4.1	Zeolite- and lawsonite-bearing rocks, Greenstones facies.	
	4.2	Amphibolites, Granulites facies.	
	4.3	Glucophane schists, Eclogites facies.	
	4.4	Paired metamorphic belts, Metamorphic rocks in space and time.	
		Total	**60**

SGLGCP2452: Thermodynamics and Metamorphic Petrology (1 Cr)

Practical

1. Study of Metamorphic Rocks in Hand Specimen.
2. Study of Metamorphic Rocks in Thin Section.
3. AKF, ACF and AFM projections.
4. Estimation of P-T conditions based on coexisting minerals.

Text Books and Reference Books:

- **An Introduction to Metamorphic Petrology** by **Bruce W.D. Yardley**

- **Atlas Metamorphic Rocks and their Textures** by **McKenzie, Donaldson and Guilford (***Excellent book on texture illustrations***)**
- **Essentials of Igneous and Metamorphic Petrology** by **B. Ronald Frost and Carol D. Frost**
- **Igneous and Metamorphic Petrology** by **Best (***Rock Associations***)**
- **Igneous and Metamorphic rocks under Microscope** by **Shelly (***Good introductory book on petrography***)**
- **Paired Metamorphic Belts** by **Miyashiro**
- **Petrography** by **William, Turner and Gilbert (***Good introductory book on petrography***)**
- **Petrology** by **Nockolds, Knox and Chinner (***Classic introductory book***)**
- **Petrology** by **Raymond (***Good introductory book***)**
- **Petrology of Igneous, Sedimentary and Metamorphic Rocks** by **Ehlers and Blatt (***Good introductory book***)**
- **Phase Diagrams** by **A. R. Morse (***Good introductory book on phase equilibria***)**
- **Principles of Igneous & Metamorphic Petrology** by **A. R. Philpotts (***Thermodynamics and Facies concept)*
- **Principles of Igneous and Metamorphic Petrology** by **Anthony Philpotts and Jay Ague**
- **Principles of Igneous and Metamorphic Petrology** by **John D. Winter**

Principles of Igneous and Metamorphic Petrology by **John Winter (***Good discussion on all aspects of metamorphic rocks)*

SGLGCT2453: Environmental Geology *(4 Cr) (Major 3)*

Pre-requisites:

Basic (10+2) knowledge of geology, chemistry and physics.

Course objectives:

1. Introduce environmental perspective to the geology students.
2. Introduce geology as a tool in the control of environmental pollution.
3. Equip the student with knowledge for societal needs.

Course outcomes:

At the completion of the course student would be able to

1. Understand Air, Water and Soil pollutants.
2. Apply geological methods in pollution control.
3. Select sites for geological disposal of pollutants.
4. Analyze Air, Water and Soil samples for their chemistry..

Curriculum Details:

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**Introduction and Ecology**	**15**
	1.1	Introduction, Fundamental Concepts of Environmental Geology: Present is a key to the future.	
	1.2	Concepts of Lithosphere and Atmosphere and their Physico-chemical characteristics	
	1.3	Concepts of Hydrosphere and their Physico-chemical characteristics.	
	1.4	Ecology- its meaning and Scope, Ecosystem Concept, Energy Flow in Ecosystem, Food chain and Food web, Ecological pyramid.	
2.0		**Air Pollution**	**15**
	2.1	Classification of Air Pollutants, Sources of Air Pollutants.	
	2.2	Indoor Air Pollution, Air Pollution and Meteorology, Air Quality Monitoring.	
	2.3	Consequences of Air Pollution-Acid Rain, Ozone Depletion.	
	2.4	Green House Effect and Global Warming, Effects of Air Pollution on life.	
3.0		**Water and Soil Pollution**	**15**
	3.1	Types of water pollutants- physical, chemical, biological, Classification of pollutants- Inorganic pollutants, organic pollutants, Biological pollutants, sediments, Oxygen demanding waste, Disease causing agents, Radioactive pollutants.	
	3.2	Sources of water pollution- Point sources, Non point sources, Natural and Anthropogenic sources, Sewage and domestic waste, Industrial effluent, Agricultural discharges, Fertilizers, Pesticides, Detergents, Herbicides, Toxic metals, Thermal pollutants.	
	3.3	Types of pollution- Groundwater pollution, Surface water pollution- Lake water pollution, River water pollution, Eutrophication, Marine pollution, Effect on life..	
	3.4	Definition, Composition of Soil, Soil formation, Soil profile, Types of Soils, Pedogenic processes, Texture of Soil, Soil pH, saline and alkaline Soil, Cation Exchange capacity, Soil pollution by- urban waste, agricultural practices, chemical and metallic pollutants, Industrial effluent, Detrimental effects on Soil, Integrated Pest Management.	
4.0		**Pollution Control and Solid Waste**	15
	4.1	Pollution Control for Air.	
	4.2	Water and Soil- Decontamination Procedures and Methods, Remedial Measures and role of Geology.	
	4.3	Solid, Liquid, Hazardous Waste Disposal and management, Geological solutions for environmental problems, Geological factors in selection of Sites for Disposal.	
	4.4	Environmental Impact Assessment (EIA).	
		Total	**60**

SGLGCP2453: Environmental Geology (1 Cr) Practical

1. Physico-Chemical analysis of Water and Soil.
2. Plotting of Data.
3. Calculation of Different Ratios for Water Quality Assessment.

- ***Text Books and Reference Books:***

- **Air Pollution** by **B. K. Sharma**
- **An Introduction to Environmental Pollution** by **B. K. Sharma**
- **Environmental Geology** by **Carla W. Montgomery**
- **Environmental Geology** by **K. S. Valdiya**
- **Environmental Geology, Handbook of Field Methods and Case Studies** by **Klaus Knödel, Gerhard Lange and Hans-Jürgen Voigt**
- **Environmental pollution and control** by **P. Aarne Vesilind**
- **Environmental Pollution Monitoring and Control** by **Shripad Moreshwar Khopkar**
- **Fundamentals of Soil Science** by **Henry D. Foth**

SGLGET2451: Computer Applications in Geology *(3 Cr) (Elective 1)*

Pre-requisites:

Basic knowledge of Geology and Computer + Basic Software.

Course objectives:

1. Teach fundamental concepts in computer organization and growth.
2. Teach application of computers and software in geological sciences.
3. Teach Basic computer programming and software relevant to geology.

Course outcomes:

At the completion of the course student would be able to

1. Use MS Office in processing and presenting geological data.
2. Prepare geological maps using Adobe Illustrator and Coral Draw.
3. Process large amount of geological data.
4. Apply ANN to evaluate geological data.

Curriculum Details:

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**Introduction**	**15**
	1.1	Computer organizations, architecture and peripherals.	
	1.2	Types of computers; Computer generations, Concept of operating system.	
	1.3	MS office – Word, Excel.	
	1.4	Power point; Internet.	
2.0		**Computer programmes**	**10**
	2.1	Computer programmes useful for geoscientific studies: application of Surfer, Use of Grapher, Excel, etc.	
	2.2	Windows-based software applications, including word-processing, spreadsheets.	
	2.3	Graphic image manipulation, drawing, presentations (MS-Excel, Power Point, Adobe Illustrator, CorelDraw, Photoshop).	
	2.4	Elementary concepts on Knowledge Based Expert System, Decision Support System, Neural Network, Fuzzy Logic and Genetic Algorithm.	
3.0		**Use of computers and software**	**10**
	3.1	Use of computers and software as tools in the areas of geology.	
	3.2	Use of computers and software as tools in the areas of geological problem-solving, report-writing, and presentations.	
	3.3	Specific applications in Geological studies .	
	3.4	Geological field data plotting software.	
4.0		**Use of computers and software**	**10**
	4.1	Database - definition, structure, and types.	
	4.2	Geological database.	
	4.3	Construction of geological maps and sections using Adobe Illustrator and Coreldraw.	
	4.4	Use of Software Packages in Geology.	
		Total	**45**

SGLGEP2451: Computer Applications in Geology (1 Cr) Practical

1. Mastering MS Office.
2. Processing Large Data Sets using relevant software.
3. Use of Adobe Illustrator and Corel Draw for geological maps and sections.
4. Geological data plotting and interpretation by using softwares.

- ***Text Books and Reference Books:***

- **Computer Application in the Earth Sciences** by **Daniel Merriam**
- **Computer Applications in Petroleum Geology** by **Joseph E. Robinson**
- **Computer Applications in the Earth Sciences** by Merriam**, Daniel (Ed.)**
- **Computer Fundamentals** by **Pradeep K. Sinha and Preeti Sinha**
- **Computer Modeling of Geologic Surfaces and Volumes (AAPG computer applications in geology)** by **David E. Hamilton**
- **Fundamentals of Computer** by **V. Rajaraman**
- **Use of Microcomputers in Geology (Computer Applications in the Earth Sciences)** by **Hans Kürzl and Daniel F. Merriam (Editors)**

SGLGET2452: Geomorphology and Morphotectonics *(3 Cr) (Elective 2)*

Pre-requisites:

Basic (10+2) knowledge of surface geological processes, geographical landforms and Geotectonics + good observational skills.

Course objectives:

1. Identification of different geomorphological features and their mode of formation.
2. Exogenous processes and natural agents controlling the surface geology.
3. Concept of landform development and their stages of evolution with time.
4. Continental drift and plate tectonics on global scale.
5. Mode of formation of continental and oceanic crust and their interaction during plate movement.
6. Identification of different tectonic features globally.
7. Endogenous processes and driving forces controlling the tectonic features.
8. Drainage basin analysis and their application.
9. Morphometric and morphotectonic analyses to evaluate landform tectonically active or not.

Course outcomes:

Students who earn minimum grade should be able to

1. Identify of geomorphological features and their controlling natural agents.
2. Understand the processes of geological weathering and erosion and their acceleration rates at different climatic condition.
3. Understand the mechanism of soil formation and their types.
4. Lithospheric plate movement and their driving forces.
5. Lithospheric plate interaction and their products.
6. Regional tectonic features and their controlling mechanisms.
7. Morphometric analyses to evaluate surface geology.
8. Morphotectonic analyses to evaluate land surface tectonically active or not.
9. Different structural features and their orientation to understand tectonic correlation.

Curriculum Details:

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**Surface Geology**	**15**
	1.1	Evolution of Earth; Principle of uniformitarianism; origin, differentiation and internal structure of the Earth and their reflections on surface geology; origin of atmosphere.	
	1.2	Weathering processes and products. geological action of rivers, wind, glaciers, waves; erosional and depositional landforms.	
	1.3	Major geomorphic features of India- coastal, peninsular and extra-peninsular.	
	1.4	Formation of soil, physiographic features and river basins in India. Hydrographs and flood frequency analysis.	
2.0		**Geotectonics**	**10**
	2.1	Concepts of Continental drift, sea-floor spreading, Isostasy, orogeny and plate tectonics.	
	2.2	Earth's internal structure; earthquakes and volcanoes; hot spot and mantle plume.	
	2.3	Concept of plate, types of plates, Plate driving forces, Plate collision: types, products; Wilson cycle.	
	2.4	Regional tectonic features of continents and ocean; Himalaya formation; Deccan trap formation.	
3.0		**Tectonic Geomorphology**	**10**
	3.1	Geotectonic endogenous process and features.	
	3.2	Folds and faults,.	
	3.3	Joints and fractures.	
	3.4	Volcanoes.	
4.0		**Tectonic Geomorphology**	**10**
	4.1	Global morphotectonics, local morphotectonics.	
	4.2	Drainage patterns; Morphometric and morphotectonic analyses.	
	4.3	Drainage basin morphometry; morphometric parameters; morphometric analysis case studies.	
	4.4	Structural and lithological controls of landforms and drainage patterns; concept of neo-tectonics.	
		Total	**45**

SGLGEP2452: Geomorphology and Morphotectonics (1 Cr) Practical

1. Geomorphological landforms models
2. Introduction to topographical maps
3. Geomorphological and geological map symbols
4. Regional tectonic feature identification on tectonic maps
5. Drainage basin analysis
6. Morphometric analysis parameters
7. Morphotectonic analysis parameters
8. Structural features and their orientation
9. Strike and dip calculation..

- ***Text Books and Reference Books:***

- **Aerial photographs in field geology** by **L.H. Lattman and R.G. Ray**

- **Geomorphology: A systematic Analysis of Late Cenozoic Landforms** by **A.L. Bloom**

- **Introducing Physical Geography** by **Alan Strahler**
- **Introduction to Physical Geology** by **Thompson and Turk.**
- **Morphotectonics** by **Adrian E. Scheidegger.**

- **Physical Geology** by **Diane H. Carlson, Charles C. Plummer and Lisa Hammersley**

- **Principles of Geomorphology** by **William D. Thornbury**
- **Process Geomorphology** by **D.F. Ritter, R.C. Kochel and J.R. Miller**

- **Tectonic Geomorphology** by **Douglas W. Burbank and Robert S. Anderson**
- **Terrain Analysis** by **D.S. Way**

Guidelines for Course Assessment:

A. Continuous Assessment (CA) (20% of the Maximum Marks):

This will form 20% of the Maximum Marks and will be carried out throughout the semester. It may be done by conducting **Two Tests** (Test I on 40% curriculum) and **Test II** (remaining 40% syllabus). Average of the marks scored by a student in these two tests of the theory paper will make his **CA** score (col 6).

B. End Semester Assessment (80% of the Maximum Marks):

1. **ESA Question paper will consists of 6 questions, each of 20 marks.**
2. **Students are required to solve a total of 4 Questions.**
3. **Question No.1 will be compulsory and shall be based on entire syllabus.**
4. Students need to solve **ANY THREE** of the remaining Five Questions (Q.2 to Q.6) and shall be based on entire syllabus.

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