MODIFIED COURSE STRUCTURE AND SYLLABUS (CBCS) OF TWO YEAR (4 SEMESTER) M. SC. COURSE IN APPLIED GEOLOGY

(Approved in BOS, Applied Geology held on 16.11.2021 and adopted by PG Board on .....)

DEPARTMENT OF APPLIED GEOLOGY
DIBRUGARH UNIVERSITY
DIBRUGARH

RATIONALE

The Department of Applied Geology was established in 1970 and a 3-year M.Tech. in Applied Geology was started. The course was designed to be a balanced blend of pure and applied aspects of Geology. In between modifications were brought into the syllabus for keeping the course up to date. A thorough change in the course structure and contents was felt necessary by the members of the teaching staff of the Department of Applied Geology, D.U. in several meetings of the Departmental Management Committee. Accordingly two meetings of the Board of Studies were held in 1994 and 1997 where the members of BOS and teaching staffs discussed and reviewed the existing structure and contents of the M.Tech. course in Applied Geology and decided to request the D.U. authorities to introduce a 2-year (4 semester) M.Sc. course in Applied Geology and the University is pleased to approve the proposed course w.e.f. January 1998. Since then a 2-year(4 semester) M. Sc. course in Applied Geology in light of the U.G.C. guide lines, 1991 has been conducted with the intention to give proper coverage to all subjects having applied aspects including field and industrial training. The M. Sc. course in Applied Geology was reviewed as per recommendations of UGC MODEL CURRICULUM on Earth Sciences, 2001. The course was brought under CBCS programme in 2008 and accordingly the syllabus was modified in 2009. Again it was revised in 2018. The present revision is based on Dibrugarh University Regulations for the academic programmes under the Choice Based Credit System (CBCS), 2018, referred as DUCBCS PG Regulations.

This revised syllabus shall be applicable to the students enrolled in the Department of Applied Geology under CBCS from the Academic year 2019-20.

Applied Geology is a subject based on practical and applied aspects of different branches of Geology. Without the practical knowledge and field experiences of the subject it is difficult to have the better understanding of the subject. To a greater extent it is an Industry Oriented course and care has been taken to prepare the students to cater the needs of industries as well as research organizations. The course structure is designed as per the requirement of the earth system science, societal needs of the region in particular.

The framework contains CORE COURSE, DISCIPLINE SPECIFIC ELECTIVES (DSE), GENERIC ELECTIVES (GE), ABILITY ENHANCEMENT COURSE (AEC) as per the CBCS guidelines. Certain modifications have been made in the course structure in regards to theory and practical aspects of the CORE, DSE and GE. The theory papers of the course have a weightage of three credits and practical papers with one credit, in total four credits for each paper. The field work, industrial training and project works are compulsory for each student to understand the practical aspects of the subject as well as up-to-date industrial practices. The students must have fair knowledge of understanding of the subjects concerned and also recent trends developed in the subject through interactions with eminent professionals from industry and Universities for

delivering lectures and impart hands on training whenever necessary as there is an Industry-Academia interface in the course programme.

The End Semester practical examinations are essential part of the course. Students must secure minimum 45% and 50% qualifying marks in individual paper in the end semester theory and practical examinations respectively. If any student fails either in theory or practical, then only the concerned paper will be considered for reappearing as compartmental examination within the period as specified by the University. There will be also a provision for betterment examinations in theory papers within the same period.

As per rules, the question papers of at least 50% of the Core Courses (theory) shall be set by external experts. The second and fourth semester practical examinations are to be conducted through external examiners from academia/industry.

Eligibility for Admission:

M.Sc. in Applied Geology

- Graduates in Geology (Major) with Mathematics, Physics or Chemistry as pass course
- Geology (Major), Physics & Chemistry.
- Geology (Major), Chemistry & Botany and Geology (Major), Chemistry & Environmental Science

Note: Candidates without Mathematics in the degree level must pass the 10+2 (Science) Exam. with Mathematics.

Note : Suggestions came from members of PG Board to open up combination.
Candidates having no mathematics in the degree level must pass the
HSSLC Exam. with mathematics.

Preference will however be given to the candidates having Mathematics as one of the subjects in his/her combination at degree level.

- **Discipline Specific Electives (DSE) and Generic Elective (GE) without practical**

The candidates offering DSE and GE having no practical, shall have to submit a report on a project to be undertaken by him/her on any aspect concerning recent advances in the field of study of the concerned subject.

❖ **Field Works** :

Field Training will be imparted at the end of 1st & 4th semester for field mapping techniques and Stratigraphy, mineral deposits, engineering projects including Industrial field training. Each field training will be followed by the submission of a report and a viva-voce on field work. The distribution of field work marks will be as follows :

i. Field performance - 60
ii. Field report - 25
iii. Viva -voce on field work - 15

Total = 100

During field work, the student should be trained to handle to different field equipments such as GPS, Brunton Compass, Range finders, Vector binocular etc.

❖ **Semester Assessment** :

Examination and evaluation shall be done on a continuous basis. There shall be two in-semester examinations and one end-semester examination in each course during every semester.

The in-semester (course work) marks will be awarded on the basis of the performance in the sessional examinations (class test) Viva-Voce, home assignment and participation in class seminars etc. Student shall compulsorily attend the two in-semester examinations, failing which they shall not be allowed to seat in the end-semester examinations.

In-sem examinations shall carry forty marks and end-sem examinations carrying sixty marks in its four credit course. In the seminar, a student is required to deliver a talk and submit a write up.

❖ **Project work** :

Project Works are compulsory. The problem for Project Work will be decided by the student in consultation with the proposed guide and will be finalized during the third semester so that the student may carry out a part of the project work if necessary. The student will submit the project report at the end of the fourth semester and defend his/her work before a board of examiners consisting of both Internal and External Examiners. The committee will also evaluate all the Project reports.

❖ **Examinations** :

The examinations will be conducted as per the Dibrugarh University Regulations for the M.A./M.Sc./M.Com. Examinations in the Semester system 2000/2008.

❖ **Evaluation and declaration of results:**

The course teacher shall evaluate the answer sheets and submit the marks to the chair person of the departmental CBCS board. The departmental CBCS board shall finalised the results of each examination/semester and notify the same before sending to the controller of examination for preparation of grade sheets and declaration of results.

- **Student Redressal:**

A student may apply to the departmental CBCS board for scrutiny and revision of the marks awarded in any of the courses within one week following proper procedure. The departmental CBCS board may have the answer scripts of the aggrieved students re-examined by the course teacher, if the appeal of the student is found to be genuine.

- **General:**

For any other matter not covered under regulations of the DUCBCS programs, the existing DU rules, ordinances and DU act, 1965(as amended) shall be applicable.

Course structure:

The course structure of the academic programmes under the CBCS shall be as follows:

a) Core Courses: Compulsory component of an Academic Programme. These courses are to be compulsorily studied as a core requirement for the programme. All core courses shall be of 4 (four) credits each.

b) Elective Courses: Elective courses should be chosen by each student from a pool of courses. The courses shall be of 4 (four) credits each. The elective courses shall be of two kinds as follows:

(i) Discipline Specific Elective (DSE): These courses shall be intra-departmental, which shall be-

- Supportive to the discipline of study
- Provide an expanded scope
- Enable an exposure to some other discipline/domain
- Nurture student proficiency/skill

(ii) **Generic Elective (GE):** These courses shall be interdepartmental/ interdisciplinary. The students shall have to opt at least 2 (two) courses from other departments according to his/her area of interest.

c) Ability Enhancement Course (AEC): The AEC shall be interdisciplinary in nature. The courses shall be of 2 (two) credits. The AECs may be either Ability Enhancement Compulsory Course (AECC) or Skill Enhancement Course (SEC) in nature.

Besides, there shall be few courses conducted under the UGC's Programmes on Massive Open Online Courses (MOOC)s like SWAYAM.
The University may from time to time fix relevant criteria for choosing the MOOCs.

DEPARTMENT OF *APPLIED GEOLOGY* : : DIBRUGARH UNIVERSITY

Course Structure of M. Sc in *Applied Geology* under Choice Based Credit System (CBCS)

Course structure for M.Sc in ***Applied Geology*** under Choice Based Credit System (CBCS) as approved by the Board of Studies in ***Applied Geology*** held on **13/03/2019.**

The Post Graduate Programme in ***Applied Geology*** shall be of four semesters covering two academic years. A student has to register at least **92** Credits in two academic years.

First Semester : 20 credits (core)+ 4 credits (DSE)+2 credits (AEC)= 26 credits (total)
Second Semester : 16 credits (core)+ 4 credits (DSE)+ 4 credits(GE) =24 credits (total)
Third Semester : 12 credits (core)+ 4 credits (DSE)+
4 credits (GE)+ 2 credits (AEC) = 22credits(total)
Fourth Semester : 16 credits (core) + 4 credits (DSE) = 20 credits (total)
Grand Total = 92 Credits

Semester	Course Code	Title of the Course	Credits			Course Teacher
			L	P	Total	
COURSES						
1st Semester	**Core Subjects**					
	AG101T	Structural Geology and Tectonics	3	-	**3**	**TKG**
	AG102T	Mineralogy and Thermodynamics	3	-	**3**	**RKS +PB**
	AG103T	Paleontology	3	-	**3**	**KDK**
	AG104T	Stratigraphy	4	-	**4**	**DB**
	AG105	Geological Field Work	-	4	**4**	
	PRACTICALS					
	AG101P	Structural Geology and Tectonics	-	1	**1**	**TKG**
	AG102P	Mineralogy	-	1	**1**	**RKS**
	AG103P	Paleontology	-	1	**1**	**KDK**
	TOTAL		**13**	**7**	**20**	
	Discipline Specific Electives (DSE)					
	AG1D1T	Mineral Optics	3	-	**3**	**RKS + PK**
	AG1D2T	Non-conventional Energy	4	-	**4**	**DM**
	AG1D3T	Himalayan Geology	4	-	**4**	**RKS+TKG +DBB**
	AG1D4T	Geoscientific Data Analysis with Matlab and Petrel	2	-	**2**	**(GD)**
	PRACTICALS					
	AG1D1P	Mineral Optics	-	1	**1**	**RKS + PK**
	AG1D4P	Geoscientific Data Analysis with Matlab and Petrel	-	2	**2**	**(GD)**
	TOTAL		**13**	**2**	**16**	
	Ability Enhancement Course (AEC)					

	AG1A1	Technical English and Professional Communication	2	-	**2**	SKL+GD
2nd Semester	**Core Courses**					
	AG201T	Sedimentology	3	-	**3**	**RKS+DBB**
	AG 202T	Ore and Coal Geology	3	-	**3**	**DM+MND**
	AG203T	Igneous and Metamorphic Petrology	3	-	**3**	**TKG+PB**
	AG204T	Geomorphology and Seismology	3	-	**3**	**RM+GD**
	PRACTICALS					
	AG201P	Sedimentology	-	1	**1**	**RKS+DBB**
	AG 202P	Ore and Coal Geology	-	1	**1**	**DM+MND**
	AG203P	Igneous and Metamorphic Petrology	-	1	**1**	**TKG+PB**
	AG204P	Geomorphology and Seismology	-	1	**1**	**RM+GD**
	TOTAL		**12**	**4**	**16**	
	Discipline Specific Electives (DSE)					
	AG2D1T	Rock Mechanics	3	-	**3**	**DBB**
	AG2D2T	Applied Paleopalynology	3		**3**	**DB**
	AG2D3T	Geo-statistics and Rock Physics	4	-	**4**	**GD**
	PRACTICALS					
	AG2D1P	Rock Mechanics	-	1	**1**	**DBB**
	AG2D2P	Applied Paleopalynology	-	1	**1**	**DB**
	TOTAL		**10**	**2**	**12**	
	Generic Electives (GE)					
	AG2G1T	Essentials of Earth Science	**3**	**-**	**3**	**Faculties from the Dept.**
	PRACTICALS					
	AG2G1P	Essentials of Earth Science	**-**	**1**	**1**	
			3	**1**	**4**	
3rd Semester	**Core Courses**					
	AG301T	Geological and Geochemical Exploration	3	-	**3**	**RKS + PBK + PK**
	AG 302T	Hydrogeology	3	-	**3**	**UG**
	AG303T	Engineering Geology and Remote Sensing	3	-	**3**	**DBB + RM**
	PRACTICALS					
	AG301P	Geological and Geochemical Exploration	-	1	**1**	**RKS + PBK + PK**
	AG 302P	Hydrogeology	-	1	**1**	**UG**
	AG303P	Engineering Geology and Remote Sensing	-	1	**1**	**DBB + RM**
	TOTAL		**9**	**3**	**12**	
	Discipline Specific Electives (DSE)					

	AG3D1T	Petroleum Micropaleontology	3	-	**3**	**KDK**
	AG3D2T	Ore Processing	4	-	**4**	**MND**
	AG3D3T	Fluvial Geomorphology	3	-	**3**	**RM**
	AG3D4T	Isotope Geochemistry	3	-	**3**	**PB**
	AG3D5T	Machine Learning and Artificial Intelligence for Geoscientific Applications	3	-	**3**	**GD**
	PRACTICALS					
	AG3D1P	Petroleum Micropaleontology	-	1	**1**	**KDK**
	AG3D3P	Fluvial Geomorphology	-	1	**1**	**RM**
	AG3D4P	Isotope Geochemistry	-	1	**1**	**PB**
	AG3D5P	Machine Learning and Artificial Intelligence for Geoscientific Applications	-	1	**1**	**GD**
	TOTAL		**12**	**4**	**16**	
	Generic Electives (GE)					
	AG3G1	Water Science - Policy and Governance	4	-	**4**	**SKL**
	TOTAL		**10**	**2**	**12**	
	Ability Enhancement Course (AEC)					
	AG3A1	Elements of GIS	-	2	**2**	**RM**
	Total				**2**	
4th Semester	**Core Courses**					
	AG401T	Geophysical Exploration	3	-	**3**	**SKL +GD**
	AG402T	Petroleum Geology	3	-	**3**	**KDK +DB**
	AG403T	Exploration and Development of Hydrocarbon Fields	3	-	**3**	**DM+UG+PBK**
	AG404	Industrial Field Training	-	4	**4**	
	PRACTICALS					
	AG401P	Geophysical Exploration	-	1	**1**	**SKL +GD**
	AG402P	Petroleum Geology	-	1	**1**	**KDK +DB**
	AG403P	Exploration and Development of Hydrocarbon Fields	-	1		**DM+UG+PBK**
	TOTAL		**13**	**3**	**16**	
	Discipline Specific Electives (DSE)					
	AG4D1	Project Work	4	-	**4**	
	TOTAL		**4**	**-**	**4**	

Generic Electives offered in 3rd semester by the Department of Petroleum Technology:

1. Drilling Technology
2. Petroleum Reservoir Engineering
3. Petroleum Geochemistry
4. Oil Well Production Technology
5. Environmental Technology and Management

Generic Electives offered in 2nd Semester by the Centre for Studies in Geography:

1. Environment and Development GG2G1
2. Climatology and Oceanography GG2G2
3. Geography of Gender GG2G3

Generic Electives offered in 3rd Semester by the Centre for Studies in Geography:

1. Hydrology GG3G1
2. Application of Geoinformatics in Petroleum Exploration GG3G2
3. Geography of Tribal Studies GG3G3

Note: L+ T - (Lecture+ Tutorial) of one hour duration; P- Practical of two hour duration.

Course Teachers :

1. Prof. D. Majumdar **(DM)**
2. Prof. M. N. Dutta **(MND)**
3. Prof.. U. Goswami **(UG)**
4. Prof. P. Bhattacharyya **(PB)**
5. Prof. R. K. Sarmah **(RKS)**
6. Prof. (Ms.) K.D. Kalita **(KDK)**
7. Dr. S.K. Lahiri **(SKL)**
8. Prof. P. Borgohain **(PBG)**
9. Prof. T.K. Goswami **(TKG)**
10. Dr. D. Bhuyan **(DB)**
11. Dr. D. Bezbaruah **(DBB)**
12. Dr. R. Machahary **(RM)**
13. Mr. Pranjit Kalita **(PK)**
14. Dr. Geetartha Dutta **(GD)**
15. Ms. Pallabi Borkakoty **(PBK)**

M.Sc. Syllabus for Applied Geology
(CBCS Course)

FIRST SEMESTER:

Core Course

Sl. No.	Code No.	Courses	Credit			Marks Distribution				
			Th	Prac	Total	Theory(T)		Practical(P)		Total
						End Sem	In-Sem	End Sem	In Sem	
1.	AG101T AG101P	Structural Geology and Tectonics	3	1	4	60	15	20	5	100
2.	AG102T AG102P	Mineralogy and Thermodynamics	3	1	4	60	15	20	5	100
3.	AG103T AG103P	Paleontology	3	1	4	60	15	20	5	100
4.	AG104T	Stratigraphy	4	-	4	60	40			100
5.	AG105P	Geological Field Work	-	4	4	-	-	100 (60+25+15)	-	100
Total			**13**	**7**	**20**	**240**	**85**	**160**	**15**	**500**

Discipline Specific Electives (DSE)

Sl. No.	Code No.	Electives	Credit			Marks Distribution				
			Th	Prac	Total	Theory(T)		Practical(P)		Total
						End Sem	In-Sem	End Sem	In- Sem	
1.	AG1D1T AG1D1P	Mineral Optics	3	-	3	60	15	20	5	100
2.	AG1D2T	Non- conventional Energy	4	-	4	60	40	-	-	100
3.	AG1D3T	Himalayan Geology	4	-	4	60	40	-	-	100
4	AG1D4T AG1D4T	Geoscientific Data Analysis with Matlab and Petrel	2	2	**4**	**40**	10	40	10	100
TOTAL (Only one to be opted)					**4**					**100**

Ability Enhancement Compulsory Course (AECC)

Sl. No.	Code No.	Course	Credit		Marks Distribution		
			Th	Total	Theory		Total
					End Sem	In- Sem	
1.	AG1A1	Technical English and professional communication	2	2	30	20	50
Total			**2**	**2**	**30**	**20**	**50**

SECOND SEMESTER:

Core Courses

Sl. No.	Code No.	Courses	Credit			Marks Distribution				
			Th	Prac	Total	Theory(T)		Practical(P)		Total
						End Sem	In-Sem	End Sem	In-Sem	
1.	AG201T AG201P	Sedimentology	3	1	4	60	15	20	5	100
2.	AG202T AG202P	Ore and Coal Geology	3	1	4	60	15	20	5	100
3.	AG203T AG203P	Igneous and Metamorphic Petrology	3	1	4	60	15	20	5	100
4.	AG204T AG204P	Geomorphology and Seismology	3	1	4	60	15	20	5	100
		TOTAL	**12**	**4**	**16**	**240**	**60**	**80**	**20**	**400**

Discipline Specific Electives (DSE)

Sl. No.	Code No.	Electives	Credit			Marks Distribution				
			Th	Prac	Total	Theory(T)		Practical(P)		Total
						End Sem	In-Sem	End Sem	In- Sem	
1.	AG2D1T AG2D1P	Rock Mechanics	3	1	4	60	15	20	5	100
2.	AG2D2T AG2D2P	Applied Paleopalynology	3	1	4	60	15	20	5	100
TOTAL (Only one to be opted)					**4**					**100**

Generic Electives (GE)

Sl. No.	Code No.	Electives	Credit			Marks Distribution				
			Th	Prac	Total	Theory(T)		Practical(P)		Total
						End Sem	In-Sem	End Sem	In- Sem	
1.	AG2G1T AG2G1P	Essentials of Earth Science	3	1	4	60	15	20	5	100
2.	AG2G2T	Geo- statistics and Rock Physics	4	-	4	75	25	-	-	100
TOTAL (Only one to be opted)					**4**					**100**

THIRD SEMESTER:

Core Courses

Sl. No.	Code No.	Courses	Credit			Marks Distribution				
			Th	Prac	Total	Theory(T)		Practical(P)		Total
						End Sem	In-Sem	End Sem	In-Sem	
1.	AG301T AG301P	Geological & Geochemical Exploration	3	1	4	60	15	20	5	100
2.	AG 302T AG 302P	Hydrogeology	3	1	4	60	15	20	5	100
3.	AG303T AG303P	Engineering Geology & Remote Sensing	3	1	4	60	15	20	5	100
TOTAL			**9**	**3**	**12**	**180**				**300**

Discipline Specific Electives (DSE)

Sl No.	Code No.	Electives	Credit			Marks Distribution				
			Th	Prac	Total	Theory(T)		Practical(P)		Total
						End Sem	In-Sem	End Sem	In-Sem	
1.	AG3D1T AG3D1P	Petroleum Micropaleontology	3	1	4	60	15	20	5	100
2.	AG3D2T	Ore Processing	4	-	4	75	25	-	-	100
3.	AG3D3T AG3D3P	Fluvial Geomorphology	3	1	4	60	15	20	5	100
4.	AG3D4T AG3D4P	Isotope Geochemistry	3	1	4	60	15	20	5	100
5.	AG3D5T AG3D5P	Machine Learning and Artificial Intelligence for Geoscientific Applications	3	1	**4**	**60**	15	20	5	100
TOTAL (Only one to be opted)					**4**					**100**

Generic Electives (GE)

Sl. No.	Code No.	Electives	Credit			Marks Distribution				
			Th	Prac	Total	Theory		Practical		Total
						End Sem	In- Sem	End Sem	In-Sem	
1.	AG3G1	Water science- Policy and Governance	4		4	75	25	-	-	100
TOTAL (Only one to be opted)					**4**					**100**

Ability Enhancement Compulsory Course (AECC)

Sl. No.	Code No.	Course	Credit			Marks Distribution				
			Th	Prac	Total	Theory		Practical		Total
						End Sem	In-Sem	End Sem	In-Sem	
1.	AG3A1	Elements of GIS	1	1	2	20	5	20	5	50
TOTAL					**2**	**20**	**5**	**20**	**5**	**50**

FOURTH SEMESTER

Core Courses

Sl. No.	Code No.	Courses	Credit			Marks Distribution				
			Th	Prac	Total	Theory		Practical		Total
						End Sem	In-Sem	End Sem	In-Sem	
1.	AG401T AG401P	Geophysical Exploration	3	1	4	60	15	20	5	100
2.	AG402T AG402P	Petroleum Geology	3	1	4	60	15	20	5	100
3.	AG403T AG403P	Exploration and Development of Hydrocarbon fields	3	1	4	60	15	20	5	100
4.	AG404	Industrial field training	-	4	4	-	-	100	-	100
TOTAL			**9**	**7**	**16**	**180**	**45**	**160**	**15**	**400**

Discipline Specific Electives (DSE)

Sl. No.	Code No.	Elective	Marks Distribution			
			Credit	Field Study/Laboratory Investigation/Project report writing	Viva voce test	Total
1.	AG4D	Project work	4	75	25	100
TOTAL			**4**	**75**	**25**	**100**

TOTAL CREDITS & MARKS OF COMPULSORY SUBJECTS:

Semester	Credits	Marks
First Semester	26	650
Second Semester	24	600
Third Semester	22	550
Fourth Semester	20	500
TOTAL (Minimum)	**92**	**2300**

Annexure – I

Details Syllabus of the *M. Sc.* Programme in *Applied Geology* under Choice Based Credit System : Session 2021 – 2022

FIRST SEMESTER

Course No. : **AG101T, AG101P**
Title of the Course : **STRUCTURAL GEOLOGY and TECTONICS**
Name of the Course Teacher : **Prof. Tapos Kr. Goswami**

Unit	Topic	No of lectures
	STRUCTURAL GEOLOGY	
I	**Introduction to Rock Mechanics**: Mechanical behavior of rocks and their controlling factors. Concept of stress and strain. Stress at a point in a solid body. 3D stress tensor. Types of stress and strain. Mohr diagram for stress and strain. Theory of rock failures.	5
II	**Folds:** Fold interference and superposed folds. Mechanics of folding and buckling. Folding in shear zones	4
III	**Faults and joints:** Mechanics of faulting: Anderson's theory and its limitations. Geometry of normal, strike slip and thrust faults. Palaeostress analysis with fault slip data. Geometric analysis of joints	5
IV	**Shear zones**: Shear zones and their significance in crustal evolution. Shear/ fault zone rocks, grain scale deformation mechanism in mylonites	5
V	**Unconformities**: Classification of unconformities; map and outcrop patterns. Distinguishing characteristics of fault and unconformity in the field.	3
VI	**Basics of Experimental Structural Geology**: Analogue modeling of deformational structures. Published examples of sandbox experiments	2
	TECTONICS	
VII	**Constitution of the Earth's Interior**. **Plate Tectonics** : Theory of the Plate Tectonics, Plate Boundaries, Mechanics of Plate Movement, Significance of plate tectonics in Petroleum Exploration, Plate tectonics and vulcanicity, Plate Tectonics and unconformity, Island arc System. **Structure &Tectonics of India** – with special emphasis on Tectonics of Eastern Himalayas and Assam-Arakan Folded belt	2 12 10
VIII **Practical** **AG101P**	Preparation of cross sections and interpretations of geological maps representing different structural settings and geological histories. Completion of outcrops in a map – three point problems. Geometric solution of problems involving inclined strata. Stereographic solution of problems involving inclined strata. Paleostress analysis from fault slip data	**2 hours duration: one class per week**

Total Lectures + tutorials of 1 hour duration : 48
Practical classes of 2 hours duration : one per week
Total Credits : 4 Theory – 3 Credits
: Practical- 1 Credit

Course description

Structural geology is a broad subject which deals with the ductile or plastic deformation of the rocks of the middle and lower crust and deformation in the frictional regime of the upper crust. Therefore structures in the rocks (regional to outcrop scale and to microscopic scale) provide the basic control for the search of minerals of economic importance, and in the understanding of the geologic setting in the study of petrology, palaeontology, stratigraphy, geomorphology, hydrogeology and engineering geology. Tectonics deals with the origin of the large scale structures in the earth which involve the movements of the lithospheric plates.

Objectives

The course is designed to familiarise students about the stress -strain behaviour of rocks, through rheology to brittle deformations in the regional to outcrop scale. The course is expected to help students in the 3D visualisation of the geologic structures, geological maps and representation of data pertaining to field structural mapping.

Course delivery

The course is delivered though a series of teaching modules and makes students accustomed with the structures at different scale and application of his or her understanding in the field of mineral exploration and large civil constructions.

Outcome expected

The outcome expected through the course is to produce students with sound knowledge of structural geology and its applicability in different sectors of the exploration and civil construction. Further, the course is also beneficial for students who may be engaged in the high quality research in the subject and for those who may be engaged in the teaching profession.

Suggested Books:-

Structural Geology

- Fossen, H. 2010. Structural Geology, Cambridge University Press, ISBN: 978-0-521-51664-8,
- Pluijm, B. A. V.D., and Marshak, S, 2003. Earth Structure. Second Edition. W.W. Norton and Company. ISBN 0-393-92467-X.
- Ramsay, J. G., 1967. Folding and fracturing of rocks. McGraw-Hill, New York
- Ramsay, J.G., and Huber, M.I., 1983. The techniques of modern structural geology, Vol.1, Strain Analysis. Academic Press, pp.1-308.
- Ghosh, S.K., 1993. Structural Geology: Fundamentals and Modern Developments, Pergamon Press, Oxford, p 598.
- Passchier, C. W., and Trouw, R. A. J., 2005. Microtectonics, 2nd Edn., Springer Verlag, Berlin.
- Pollard, D. D. (2005) Fundamental of Structural Geology. Cambridge University Press.
- Ragan, D. M. (2009) Structural Geology: an introduction to geometrical techniques (4th Ed). Cambridge University Press (For Practical)

Tectonics

- Kent C Condie 1989, Plate tectonics and crustal evolution , Pergamon Press plc
- Gobal Tectonics 2009, Philip Kearey, Keith A. Klepeis and Frederick J Vine, Wiley-Blackwell 3rd Ed.
- Arc-Continent Collision, 2010, Dennis brown Paul D Ryan (Eds), Springer
- Kusky T. M. , Zhai, M. G., & Xiao W., The Evolving Continents: Understanding Processes of Continental Growth, The Geological Society of London (Special Publication)
- Nandy, D. R., 2001. Geodynamics of North East India and adjoining region. ACB Publishers, Kolkata, 205p.
- Dasgupta, A.B. & Biswas, A.K. 2000. Geology of Assam, Geol. Soc. Ind., 170p

Course No. **: AG102T, AG102P**

Title of the Course **: Mineralogy and Thermodynamics**

Name of the Teacher & Course **: Prof. R.K. Sarmah (Mineralogy)**

Unit	Topic	No. of Lectures
I	1. Crystals and crystallization, crystal growth & habit. Mineral genesis & associations. 2. Interaction of light waves with Isotropic & Anisotropic minerals. Optical properties of minerals and their application in mineral identification. 3. Determination of optical properties of minerals with a polarizing microscope.	10
	4. Systematic study of important rock forming minerals: olivine, epidote, pyroxene, amphibole, feldspars, mica and quartz group minerals, with reference to their atomic structure, optical characteristics, origin and association.	10
II	5. Principles of crystal chemistry: ionic size, charge and polarizability. Chemical bonds. Mineral transformations: classification of transformations, polymorphic transformation, polymorphic transformations involving exsolution.	5
	6. Clay mineralogy- clay structure and application of clay mineralogy.	2
	7. Mineral Analysis: DTA, IR spectrometry, XRD and SEM, X-ray crystallography.	5
	8. The role of mineralogy in mineral processing.	2
III (Practical) AG102P	1. Preparation of thin section of minerals. Determination of RI, Pleochroic scheme, Order of Interference Colour and Optic Sign.	**2 hours duration: one class per week**
	2. Determination of plagioclase feldspar by Michael Levy method. Staining, etching techniques for mineral identification, use of universal stage, Modal count techniques.	
	3. Microscopic study of common rock forming minerals using optical accessories.	
	4. Study of x-ray diffractograms for identification of common minerals.	

Course Description:-

Mineralogy is a fundamental topic in geology. Minerals are the basic building blocks of the solid Earth materials and also used as raw materials for mineral based industries. This requires a fundamental knowledge in mineral genesis, associations and occurrence to understand the mineralogical processes.

Objectives:- This course is designed to gain basic principles and concepts behind the arrangement of atoms to form crystal structures and how this is reflected in the external form, chemical composition and mineral properties.

Course delivery:-It provides necessary descriptive and optical information to identify the most common minerals in thin section. Special techniques of mineral analysis are emphasized in the course. Moreover the microstructure of minerals in mineral processing is highlighted. Crystal chemistry and mineral behavior under different pressure and temperature conditions will be discussed in this course. This course is designed to understand the characteristic structures of major mineral groups, mineral chemistry and the need of minerals in mineral processing industry.

Outcome Expected:- The learning outcome of the course is to demonstrate understanding of the distinction between light velocity, vibration direction, propagation direction and wavelength and interaction of light with isotropic and anisotropic minerals special to understand basic principles of analytical techniques and be able to use this knowledge to simple mineral phase identification., and to identify an unknown mineral based on optical properties and optical techniques.

Suggested books:

- Bloss, F.D. Crystallography and crystal chemistry
- Mason. B., Principles of Geochemistry
- Deer. Llowie and Zussman. Rock minerals Vol. 1 to Vol 5 and also condensed volume
- Putnis. Mineralogy
- Reviews in Mineralogy. Vol. 2,3,5,7,9A,9B, and 13 (Mineralogical society of America)
- Henrich E.W.M. Microscopic identification of minerals. Magrohill Book Company. 1965.
- Jones M.P. Applied mineralogy a quantitative approach. 1987. Graham and Trotman.

Name of the Teacher & Course: Prof. P. Bhattacharyya (THERMODYNAMICS)

Unit	Topic	No. of Lectures
I	1. Introduction to thermodynamics : Fundamental thermodynamic equations : 1st, 2nd and 3rd laws, Gibbs free energy, Chemical potential, partial molar properties, standard states, activities, fugacities.	4
	2. Free energy and phase equilibria :	
	2.1 Concept of Equilibrium	1
	2.2 Gibbs – Duhem Equation	1
	2.3 Free energy of formation at any temperature and pressure.	1
	2.4 Free energy surface at G.T.P. space.	2
	2.5 Plotting of univariant lines in P.T. diagrams.	2

II	3. Study of phase equilibria: The phase rule – one, two and three component systems and their significance in petrogenesis.	5
	4. solutions:	
	4.1 Introduction	1
	4.2 Ideal and Non- ideal solution	1
	4.3 Dilute solution and Henry's law	1
	4.4 Range of applicability of Henry's law	1
	4.5 Duhem – Margule's Equation for binary solution	2
	4.6 Trace components as monitors of igneous rocks.	2

Total Lectures + tutorials of 1 hour duration : 48
Practical classes of 2 hours duration : one per week
Total Credits : 4 Theory – 3 Credits
: Practical- 1 Credit

Course description:- Igneous and Metamorphic rocks can be considered as chemical system where the thermodynamics is an important component. Thermodynamic laws, properties, phase rule and phase diagrams. trace element fractionation are all essential to understand both igneous and metamorphic petrology;- their petrogenesis, geothermometry and geobarometry.

Objective:- The course is framed in such a was to make the students understand the thermodynamic properties,different laws and their applications in understanding igneous and metamorphic petrology.

Course delivery:-The course will be delivered with different teaching modules and hands-on training in laboratory supported by theory classes for different plotting sand computation s.

Outcome expected:- At the end, students will have sound knowledge of thermodynamics- its application in igneous and metamorphic petrology. Further, students will be made ready for Research works as well as preparing themselves for various competitive examinations.

Suggested Books:

- Wood, B.J. and Fraser, D.G., Elementary Thermodynamics for Geologists, Oxford University Press, 1976.
- Lakhenpal, M.L., Fundamentals of Chemical Thermodynamics, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1983.
- Best, M.G., Igneous and Metamorphic Petrology, CBS Publishers & Distributors, New Delhi, 1986.
- Rao, B., Metamorphic Petrology, IBH Publishing Company Pvt. Ltd., New Delhi, Bombay & Calcutta, 1986.
- Tunner, F.J. & Verhoogen, J., Igneous and Metamorphic Petrology, McGraw-Hill Book Company, INC Yew York, 1960.
- Philpotts A.R., Principles of Igneous and Metamorphic Petrology, Prentice Hall India Pvt. Ltd., New Delhi, 1994.
- Ernst, W.G., Petrologic Phase Equilibria, W.H. Freeman & Company, San Francisco, 1976.

Course No. **: AG103T, AG103P**

Title of the Course **: PALAEONTOLOGY**

Name of the Course Teacher : Prof. (Ms.) Kalpana Deka Kalita

Unit	Topic	No. of Lectures
I	1. Organic life, fossil, types of fossils, and their application in geological sciences. Calcium Carbonate Compensation Depth. Environmental significance of Trace fossils	2
	2. Introduction to Taphonomy. Modes and conditions of preservation of fossils and taphonomic considerations.	2
	3. Organic evolution – Punctuated Equilibrium and Phyletic Gradualism models	2
	4. General principles of palaeontology: Phylogenetic and Phenetic classification Concept of species Naming of genera and species Binomial system of nomenclature Type specimens.	3
II	5. Microfossils, what are they? Classification of microfossils Micropalaeontological techniques for extraction of faunas	2
	6. Morphology and geological distribution of Foraminifera Radiolaria Ostracoda. Palaeoenvironment interpretation with these microfaunas	8
	7. Introduction to Palynology Palynological technique	2
	8. Palynological guide fossils of India	2
	9. Morphology and geological distribution of Spores and pollen grains Dinoflagellates Calcareous algae Diatoms Acritarchs, Calcareous nannoplankton (coccoliths) Palynodebris and palaeoenvironment interpretation with these microorgainsms	10
	10. Cretaceous-Palaeocene-Eocene microfossil assemblages of Assam, Meghalaya and Arunachal Pradesh and their age and environmental significance	1
	11. Application of microfossils (fauna and flora) in a. Hydrocarbon exploration b. Palaeooceanographic interpretation c. Climate change interpretation	3
	12. Oxygen and Carbon Isotope studies of microfossils.	1
	13. Introduction to Biofacies, Microfacies and Palynofacies	2
	14. Biostratigraphy and biostratigraphic zonation	2

III	15. Biomineralization Ultrastruture	1
	16. Biomarker	1
	17. Palaeobiogeography	2
	18. Palaeoecology, Life habitats and various ecosystem	2
IV PRACTICAL AG103P	Micropalaeontological techniques: Sample treatment, maceration, washing, Drying, picking and storage	**2 hours duration: one class per week**
	Thin section preparation	
	Taxonomic identification and systematic description of foraminifera, ostracoda and radiolaria.	
	Taxonomic identification and systematic description of spore, pollen, dinoflagellate, algae and palynodebris	

Total Lectures + tutorials of 1 hour duration : 48
Practical classes of 2 hours duration : one per week
Total Credits : 4 Theory – 3 Credits
: Practical- 1 Credit

Descriptions:- Paleontology plays an important role in geological sciences, providing the main method of dating geological sequence; establishing biostratigraphy and sequence biostratigraphy; reconstructuring palaeobigeography, evolutionary history, interpreting palaeoenvironment and climate change and exploring hydrocarbons.

Objective: The course is designed to provide the students a detailed coverage of the key mega and microfossil groups and to focus on the contribution of palaeontology in understanding Earth Science.

Course delivery: The course is delivered through a series of taught modules focusing on the key mega and microfossil groups and their applications.

Outcome expected: The course is mainly designed to prepare students for work in the geological and related service sector with a knowledge of mega and micropalaeontology in details. The skills acquired by the students will also provide a strong foundation for those wishing to undertake further postgraduate study towards the award of a Ph D in micropalaeontology. The students will be prepared for teaching professions also.

Suggested Books:

- Applied Geological Micropalaeontology: P. K. Kathal, Scientific Publishers, India
- Invertebrate Fossils: Moore, Lalicker, Fisher, CBS Publishers
- Principles of Invertebrate Palaeontology: Robert R. Shrock and William H. Twenhofel, CBS Publishers & Distributors
- Applied Micropalaeontology: Ed. David Graham Jenkins, Kluwer Academic publishers
- An Introduction to Palaeontology: Amal Dasgupta, World Press
- Micropalaeontology in Petroleum Exploration: Robert Wynn Jones, Oxford Science Publication
- Palaeontology – An Introduction: E. W. Nield and V. C. T. Tucker, Pergamon Press
- Palaeontology (Palaeobiology) Evolution and Animal Distribution, Dr. P.C. Jain and Dr. M. S. Anantharaman, Vishal Publishing Co
- Micropalaeontology: Braiser

Course No. **: AG104T**

Title of the Course **: STRATIGRAPHY**

Name of Course Teacher **: Dr. D. Bhuyan**

Unit	Topic	No. of Lectures
I.	1. Modern development in stratigraphy, Steps in stratigraphic studies. Evolution of Geological Time Scale. Significant events in geological time.	4
	2. Formal stratigraphic classifications: rock, time and time-rock units. The Stratigraphic Code, Local Example: the Jaintia Group. Lithostratigraphy. Biostratigraphy,Chronostratigraphy,MagnetostratigraphyandChemostratigraphy.	8
	3. Stratotypes, Global Boundary Stratotype Sections and Points (GSSP), Facies in stratigraphy. Walther's Law of succession of facies. Types of Stratigraphic facies.	3
	4. Methods of Correlation: physical and time (isochronous/diachronous patterns), Correlation of lithostratigraphic units,Shaw's Graphic correlation. Sediment accumulation and gaps in the stratigraphic record: diastems, unconformities. Stratigraphic relations. Methods for paleogeographic reconstruction.	6
	5.**Additional topics-if time permits:** Geochronology Bedrock dating: U/Pb, Rb/Sr, Ar/Ar. Quaternary dating: Radiocarbon, Uranium Series, Luminescence.	
II.	6. Sequence Stratigraphy Accommodation Space Controls (3 S's) - Subsidence (tectonics and compaction); Sea Level (Eustasy); Sediment (rates and climate) Basic terms: systems tracts, sequences, sequence boundaries, maximum flooding surfaces, parasequences, flooding surfaces, the Vail Curve. Seismic stratigraphy: Development of the concepts and their significance.	6
	7. Introduction to Quaternary Geology and its applications. Earth's Climatic History Pleistocene Glacial-Interglacial cycles.	3
III.	1. Geology of Indian Peninsula. Tectonic evolution of cratons and mobile belts in peninsular India. Introduction to important Hadean, Archaean, Proterozoic successions of Indian Peninsula: Dharwar,Singhbhum Cratons and Shillong Plateau. Proterozoic stratigraphy of CudappahVindhyan and Delhi basins.	5
	2. Distribution, Stratigraphy, Classification and Sedimentation of Gondwana sequence of India. Palaeogeography and Palaeoclimates during Gondwana Times. Distribution of Gondwana equivalents in other continents.	5
	3. Stratigraphy and distribution of Triassic rocks of Spiti, Jurassic rocks of Kutch and Cretaceous rocks of Meghalaya and Cauvery Basins.	4
	4. Volcanic provinces of India. Deccan Volcanics : Stratigraphy and Distribution and age.	2
IV.	5. Stratigraphy and Distribution of Tertiary rocks of upper Assam and Surma basins, Assam Arakan Mobile Belt, Meghalaya Basin and Arunachal foredeep.	7
	6. Geology of Himalayas: Physiographic and lithotectonic subdivisions of the Himalaya. Major thrusts and their boundaries. India & Asia collision. Lithological characteristics of subdivisions of the Himalaya. Sedimentation and evolution of Himalayan foreland and intracratonic basins.Palaeozoic, Mesozoic and Cenozoic succession of the Himalayas. Stratigraphy of the Siwalik Group.	4

	7.	Quarternary Stratigraphy of Assam.	2
V.	8.	Boundary Problems in Stratigraphy of India : Precambrian-Cambrian, Permian-Triassic and Cretaceous-Tertiary boundaries.	3

Total Lectures of 1 hour duration : 64
Total Credits after calculation : 4

Description: Stratigraphy is the backbone of the geological sciences; it brings together sedimentology, paleontology, petrology and structural geology to reconstruct Earth history. We survey the impact of sea-level change, tectonics and climate on sediment accumulation, with emphasis on seismic and sequence stratigraphy. Case studies focus on sedimentary basins across India, and practical work includes laboratory and class exercises, as well as field excursions.

Course Objective: The stratigraphy course is designed to teach students different principles on which the subject stratigraphy is based on. Indian stratigraphy is designed to provide a comprehensive information about thesedimentology, paleontology, petrology and structural geology of sedimentary basins across India.

Course delivery: The course will be delivered through different illustrative modules of stratigraphic principles, description of stratigraphic successions along with fossil distribution.

Learning Outcomes: Upon Successful completion of this course students should be able to:

1) Assess rocks and interpret their meaning in the larger context of Earth's history and Sedimentary basin evolution
2) Demonstrate in-depth knowledge and understanding of stratigraphic concepts and terminology through analysis, classification, and identification
3) Understand and explain how sedimentary series translate into knowledge regarding continental drift, climates, biological evolution, and major and singular events on Earth (i.e. mass extinctions, oceanic anoxic events, etc.).
4) Gain hands-on laboratory techniques and field experience
5) Organize ideas, summarize teachings, and describe findings for academic writing in the Earth Sciences

Suggested Books:

- Bigg, G., 1999 Ocean and Climate. Springer-Verlag
- Boyd et al. 1989. Relation of sequence stratigraphy to modern sedimentary environments Shanley et al. 1991. Predicting facies architecture through sequence stratigraphy
- Bradley, F., 2000. Paleoclimatology: Reconstructing Climates of the Quaternary. Springer-Verlag
- Doyle, P. & Bennett, M.R. 1996. Unlocking the Stratigraphic Record. John Wiley
- Krishnan, M.S. 1982. Geology of India and Burma, CBS Publishers, Delhi
- Maher and Thompson, 2000. Quaternary Climates, Environments and Magnetism. Cambridge University Press.
- Mathur and Evans, 1964. Oil in India. Proc. 18th Int. Geol. Cong. New Delhi: 1-85.
- Maurice E. Tucker, 2006, Sedimenary Petrology, BlackweI J Publishing, 262p.
- McCarthy et al. 1998. Recognition of interfluvial sequence boundaries
- Mial A.D. 1999. Principles of Sedimentary Basin Analysis. 3rdedition.Springer-Verlag.
- Naqvi S.M. 2007: Geology and evolution of Indian Plate

- Pascoe, E.H. 1968. A manual of the Geology of India and Burma (Vol.I-IV), Govt. of India Press, Delhi.
- Plint et al. 1992. Controls of Sea Level Change
- Ramakrishnan, M. &Vaidyanadhan, R. 2008. Geology of India Volumes 1 & 2, geological society of India, Bangalore.
- Sam Boggs, 1995, Pricnciples of Sedimentology and Statigraphy, Printice Hall, New Jersey, 765p.
- Schoch, R. M. 1989. Stratigraphy, principles and methods.
- Vaidyanadhan R and Ramakrishnan M. 2010. Geology of India. GSI.
- Valdiya, K.S. 2010. The making of India, Macmillan India Pvt. Ltd.
- Van Nostrand Reinhold. Roy R. Lemon. 1990 Principles of Stratigraphy, 512 pages, Publisher: Longman Higher Education.
- Van Wagoner, Mitchum, Campion &Rahmanian (1990) Siliciclastic Sequence Stratigraphy in Well Logs, Cores & Outcrops
- Weller, J. Marvin 1960. Stratigraphic principles and practice. Harper's Geoscience series.
- Williams, Durnkerley, Decker, Kershaw and Chhappell, 1998. Quaternary Environments. Wiley and Sons.

Course No. : **AG1D1T, AG1D1P**

Title of the Course : **MINERAL OPTICS**

Name of the Course Teacher : Prof. R.K. Sarmah

Unit	Topic	No. of Lectures
I	Colour of Minerals: Generation and Causes	4
	Pleochroism in minerals, Pleochroic scheme and its determination.	3
	Refractive Index in minerals. Determination of R.I. minerals by Central illumination method and Oblique illumination method.	6
II	Anistropism & Crystal structure: Isoaxial Uniaxial and Biaxial minerals and their behavior in polarized light.	9
	Exinction & Interference colour. Order of interference colour. Michel Levy Colour Chart of birefringence and its use in determination of order of interference colour.	6
	Fast & Slow Vibration Direction in minerals and their determination. Accessory plates and Compensators. Use of accessory plates.	3
III	Interference figures: Uniaxial and Biaxial interference figures. Determination of optic sign from interference figures of the minerals.	7
	Dispersion in Unixal and Biaxial minerals.	3
	Optical indicatrix. Uniaxial & Biaxial indicatrix.	4
	Universal stage and its use. Limitations of Universal stage.	3
IV Practical AG1D1P	Identification of optical properties of rock forming minerals under petrological microscope.	**2 hours duration: one class per week**
	Determination of optic signs, order of interference color and pleochroic schemes of rock forming minerals.	
	Determination of composition of Plagioclases by Michael Levey method.	

Total Lectures + tutorials of 1 hour duration : 48
Practical classes of 2 hours duration : one per week
Total Credits : 4 { **Theory – 3 Credits**
: Practical- 1 Credit

Course Description:- Minerals are inorganic chemical compounds having a certain lattice shape, size and symmetry, being a result of the geometrical arrangement of the constituents (chemical elements such as Si, Al, O, etc).Lattice (symmetry) + chemistry (nature of the chemical elements of the lattice) combine to make a unique mineral phase. The lattice (internal symmetry) of the mineral is reflected not only in the symmetry of the external crystal shape but also in the symmetry of optical properties of the mineral; therefore, determining the optical properties of an unknown phase assists in identifying the mineral phase. Microscopic study is the cheapest and fastest method for identifying minerals; however, there are limitations to the optical method, such as constraints of very small size (sub-microscopic) of minerals, or complex solid solutions, etc.

Objectives:-

Microscopic study is required for textural (natural arrangements of minerals) analysis; it is useful in determining the rock type, the crystallization sequence, deformation history or observing frozen-in reactions, constraining pressure-temperature history, noting weathering/alteration, etc. To understand the behaviour of minerals under transmitted polarized light and identification of unknown minerals using optical property determinations and catalogues of physical properties.

Course delivery:- Theoretical knowledge and practical training are very important to understand the light interaction with isotropic and anisotropic crystalline matter. Optical methods for mineral identification will be taught thoroughly by demonstration classes as well as microscopic examination.

Outcome Expected:- Mineral identification is needed in petrological studies, structural geology, mineral exploration etc. Because of the principles of light refraction and reflection are also relevant to seismicity (geophysics and geological exploration), water behaviour (groundwater management), and even to real life.

Suggested Books:-

- Manson, B. and Berry, L.G., Elements of Mineralogy, W.H. Freeman and Co., 1968.
- Dana, E.S. and Ford, W.E., A text book of Mineralogy, John Wiley & Sons, 1963.
- Deeretal, An Introduction or Rock Forming Minerals, ELBS 1978.
- Grim, R.E., Clay Mineralogy McGraw-Hill, New York 1968.
- Hutchison, C.S., Laboratory Handbook of Petrographic Techniques, New York, Wiley 1974.
- Kerr, P.F., Optical Mineralogy, McGraw-Hill Book Co., 1977.
- Blackbrun, W.H. and Dennen, H., Principles of Mineralogy, Universal Book Stall, New Delhi, 1990.
- Ray, S., Morphologic Crystallography and Optical Mineralogy, Oxford & IBH Pub. Co., 1971.
- Putnis Andrew: Introduction to Mineral Sciences.
- Wahlstrom E.E., Optical Crystallography, New York, 1969.
- Winchell AN and H. Winchell, Elements of Optical Mineralogy, John Wiley & Sons, 1968.
- Keith F., Modern Mineralogy, Prentice Hall inc., 1974.

Course No. **: AG1D2T**

Title of the Course **: Non-conventional Energy**

Name of the Course Teacher **: Prof. D. Majumdar**

Unit	Topic	No. of Lectures
I	Components of Energy : Non-Renewable and Renewable	4
	Production of Thermal energy using fossil fuels and solar energy	6
	Conversion of solar energy into various forms of energy (heat, electricity, mechanical etc.)	4
	Geothermal and Tidal Energy: Basic principles, Systems used in practice and applications Resource assessment.	8
II	Wind Energy: Wind resource assessment, various models to predict wind pattern and their analysis concept of wind farms, Classification of wind mills.	4
	Concept of Bioenergy: Photosynthesis process, Biofuels, Biomass resources Bio based chemicals and materials	4
	Biofuels-Biomass : Importance, Production and applications	4
	Hydrogen as a renewable energy source, Sources of Hydrogen, Fuel for Vehicles	4
III	Utilization of Hydrogen: Fuel cell-principle of working, construction and applications	4
	Environmental degradation due to energy production and utilization	6

Total Lectures of 1 hour duration **: 64**
Total Credits **: 4**

Course description: As conventional fossil fuel energy sources are depleting at a faster rate and the world's environmental concern about acid deposition and global warming increases, renewable energy sources (solar, wind, tidal, biomass and geothermal etc.) are attracting more attention as alternative energy sources. These are all pollution free, cost effective and eco-friendly. The course introduces the processes and scope of the alternative energy sources- their working principles and use in different countries and a glimpse on the economics etc.

Objectives: The course should enable the students to a) Understand the various forms of conventional energy resources. b) Learn the present energy scenario and the need for energy conservation c) Explain the concept of various forms of renewable energy. d) Outline division aspects and utilization of renewable energy sources for both domestics and industrial application e) Analyze the environmental aspects of renewable energy resources.

Course delivery: Course delivery will be general classroom practices, covering the theoretical aspects of the resources in terms of teaching module and slide presentation.

Outcomes Expected: Upon completion of the course, the student will be able to: a) Describe the environmental aspects of non-conventional energy resources. In Comparison with various conventional energy systems, their prospects and limitations. b)Know the need of renewable energy resources, historical and latest developments. c) Describe the use of solar energy and the various components used in the energy production with respect to applications like - heating, cooling, desalination, power generation, drying, cooking etc. d) Appreciate the need of Wind Energy and the various components used in energy generation and know the classifications. e) Understand the concept of Biomass energy resources and their classification, types of biogas Plants- applications. f) Compare Solar, Wind and Bio energy systems, their prospects, Advantages and limitations. g) Acquire the knowledge of fuel cells, wave power, tidal power and geothermal principles and applications.

Suggested Books:

- Non-Conventional Energy Sources, BH Khan, Tata McGraw Hill Publisher, 2006.
- Non-Conventional Energy Sources and Utilisation, Er. R.K. Rajput, S. Chand Publisher, 2012.
- Non-Conventional Energy Resources, G.S. Sawhney, PHI Learning Pvt. Ltd. Publisher, 2012.
- Non-Conventional Energy Resources, Dr. J.P. Navani and Er. SonalSapra, S. Chand & Company Pvt. Ltd. Publisher, 2015.
- Non-Conventional Energy Resources, ShobhNath Singh, Pearson Publisher, 2015.

Course No. **: AG1D3T**

Title of the Course **: Himalayan Geology**

Name of Course Teacher **: Prof. R.K. Sarmah, Prof. T.K. Goswami and Dr .D. Bezbaruah**

Unit	Topic	No. of Lectures
I	Introduction, importance and significance of Himalayas, their morphology, Regional, physical and geological subdivision of Himalayas	5
II	Formation of Himalayas, Indian plate margin, plate movement and rise of Himalayas, Himalayan foredeep.	7
	Brahmaputra plain and its relation with Shillong and Mikir massif .	5
	Major litho-tectonic boundaries	3
	Concept of exhumation in the Himalayas	5
III	Geology of Lesser Himalayas and Sub-Himalayas, geological history and structures, sedimentary basins, igneous and metamorphic belts with special reference to Eastern Himalayas	10
	Geology of Higher Himalayas, structural framework, inverted metamorphism, Magmatism and its geological history.	10
	Tethys Himalaya: geology, structure, and relationship with Higher Himalayas and trans-Himalayan belts.	10
IV	Himalayan seismicity, its characteristics, major earthquakes, in relation to the structure of Himalayas.	6
V	Mineral deposits and metallogeny of Himalayas	3

Total Lectures of 1 hour duration : 64
Total Credits : 4

Course description

Himalayan geology describes the structural evolution of Himalaya, pre- Himalayan tectonics, evolution of the fold and thrust belt, sedimentation and evolution of the Himalayan arc magmatism. It also describes the active tectonics in the Himalayan mountain front and the morphotectonics in the Himalayan frontal foothills.

Objectives

The objective of this course is to expose the students to the geological processes in the immediate neighbourhood of Himalayas. This course offers an unique opportunity for the students to understand the thrust tectonics and deformational history related to plate motions. Students can also get an opportunity to understand the natural hazards

Course delivery
The course is delivered though a series of teaching modules and makes students accustomed with the convergent plate boundaries and thrust tectonics. Further, inverted metamorphism and identification of different shear zones in the field and grain scale deformation are also emphasised.

Outcome expected
The outcome expected through this course is to produce students with sound knowledge of features associated with plate collision boundary and subduction zones. It is also expected students will be conversant with the mechanism and structures associated with thrust tectonics.

Suggested Books:-

- The Making of India-Geodynamic Evolution 2nd Edition, K S Valdiya, Springer, Society of Earth Scientist Series ISBN: 978-3-319-25029-8
- Himalayan Collsion Tectonics, A K Jain & Sandeep Singh, Gondwana Research Group, Memoir No.7, 2002
- Dimensions Of Himalayan Geology, A.K. Biyani, Satish Serial Publishing House (2006), **ISBN-10:** 8189304151
- Kumar, G., 1997: Geology of Arunachal Pradesh. Geol. Soc. Ind. Publ., Bangalore, 217.
- Geodynamics of NW Himalaya, Eds. A.K. Jain, & R M Manickavasgam, Gondwana Research Group, Memoir No.6, 1999.
- Geology of the Himalayan Belt, B . K. Chakrabarti, **ISBN:** 9780128020210, Elsevier 2016.

Course No. : **AG1D3T**

Title of the Course : Geoscientific Data Analysis with Matlab and Petrel

Name of Course Teacher : **Dr. Geetartha Dutta**

Unit	Topic	Number of Lectures
Unit - I	**Introduction to Matlab: Common functions and operations; Arrays: vectors and matrices; Array indexing: subscript indexing, linear indexing and logical indexing; Visualizing data: line plots, scatter plots, polar plots, rose plots, compass plots, contour plots, surface plots, histograms and images; Matrix operations and manipulations; Vectorization; Scripts and Functions.**	**10**
Unit - II	**Image processing using Matlab: Transforms: Fourier transform, discrete cosine transform, radon transform, wavelet transform; Filters: Gaussian filter, Laplacian filter, moving average filter, median filter; Frequency responses; Speckle noise removal; Image reconstruction; Edge detection; Image thresholding; Properties of image regions.**	**10**
Unit - III	**Signal processing using Matlab:Fast Fourier transform; Sampling and aliasing; Spectral analysis; Power spectral density; Cross correlation and auto correlation; Time-frequency spectrogram; High-pass and low-pass filters; Downsampling and removing trends in data; Principal component analysis.**	**10**
Unit - IV	**Simulation, regression, classification and optimization:2D random walk; Monte Carlo simulation; Bootstrapping; Kernel density estimate; Probability density functions; Empirical cumulative distribution; Linear least squares regression; Eigenvectors and eigenvalues; Polynomial fitting; Non-linear least squares regression; Classification: Logistic regression, Classification trees, Neural networks, Support vector machines; Optimization; Objective functions; Numerical solution of ODEs; Numerical integration and discretization.**	**24**
Unit - V	**Reservoir modeling using Petrel:Petrel basics; Preparing data; Making surfaces and grids; Visualization.**	**10**

Matlab is a high-level programming language and interactive environment for mathematical computation, analysis, visualization and algorithm development. Matlab is widely used in various disciplines of science and engineering which require numerical analysis, matrix computation, signal processing, image processing, simulation, regression and optimization. These applications are ubiquitous in geoscientific data analysis, and hence Matlab has extensive use in geosciences. Petrel is an Exploration & Production (E&P) software platform which integrates multiple disciplines for making better decisions.

Objective: The course is designed to provide students the basics of Matlab and Petrel, along with knowledge and practice of implementing various techniques and algorithms which are useful in geoscientific data analysis.

Course delivery: The course is delivered through a series of class lectures and hands-on exercises using Matlab and Petrel.

Outcome expected: Students, after completing this course, are expected to be well prepared to implement various techniques and algorithms in Matlab and Petrel. The knowledge and skills acquired in this course will help students in their future research, if they pursue a Ph.D. Some of the course materials, especially those involving Petrel, will also be useful in pursuing a career in the industry.

Course No. **: AG1A1T**
Title of the Course **: Technical English & Professional Communication**
Name of Course Teacher : **Faculties of Department of English**

Unit	Topic	**No. of Lectures**
I	*An introduction to scientific communication:* How is scientific communication different from providing information or education? Difference between expressing and communicating; Distinction between target group and readers/listeners/viewers; communicating for intact on target group and to engage media consumers Communicating to elicit community action: Dictyostelium model for understanding essential principles; nature of political, religious and commercial communication. Communicating science to elicit action, change or reform *Activities:* writing CV, writing proposal for conducting scientific research.	One hour duration per week
II	*Language and Science:* Nature of scientific language: Removal of first person, removal of identities, names of scientists/use of passive voice; lack of attention to spelling and grammar in teaching and learning science/ Essentials of punctuation/ Parts of speech/Tense: transitions between hypothesis, experiments and results/ connecting words, sentences and paragraphs/ converting complex nouns into simple verbs *Activities:* learning grammar using web tools, vocabulary increasing exercises, phrasal verbs.	
III	*Structural development of science and scientific thinking:* Ideas of Plato, Aristotle, Francis Bacon, Rene Descartes, David Hume, Karl Popper, Thomas Kuhn, Lakatos, Feyerabend, J D Bernal, Bruno Latour *Activities:* Quick reading of selective passages and answering questions, writing esssays on contributions of thinkers and philosophers contributing to the development of scientific thinking.	
IV	*Scientific Communication* Understanding the structure of a scientific paper Searching for and researching scientific content; google, google scholar, Academia.edu, Research gate, Databases, Directories. Reading, writing, rewriting, restructuring Art of preparing impressive powerpoint presentation. *Activities:* Asking questions, formulating keywords, searching, bookmarking, using a webclipper, organising PDF files, bibliography management.	
V	*Group Discussion(GD)* Nature of group discussions, uses and importance; Leadership function in GD; developing leadership qualities and positive group behaviour / Starting discussions: opening the discussion, stating objectives, suggesting good group procedure(time management, speaking procedure ,etc.; giving opinions, asking for opinions and supporting opinions in GD; making suggestions and asking for suggestions; Balancing points of view, expressing advantages, disadvantages and consequences; some pitfalls in discussions, fallacies in argument and rebuttal, concluding and controlling discussions.	

Total Lectures of 1 hour duration : 32
Total Credits : 2

Suggested Books:-

- Brigitte Markner-Jager, 2008. Technical English for Geosciences, A Text/Work Book, Springer
- David Horner & Peter Strutt, 1996.Words at work, Vocabulary development for Business English, Cambridge University Press
- Durant, Will, 1926.The Story of Philosophy, Simon & Schuster.
- Fowler, H.W., 1996.Fowler's Modern English Usage, Revised third edition, edited by R.W.Burchfield, Oxford University press
- Ibbotson, Mark, 2009, Professional English in Use, Cambridge University Press
- Jordan, R.R., 1999.Academic Writing Course, Study skills in English, Pearson Education Limited, UK.
- Kuhn, Thomas S., 1962.The Structure of Scientific Revolutions, The University of Chicago Press.
- Lewis, Norman, 2011.Word Power Made Easy (Indian Publisher: GOYL SAAB)
- Lewis, Norman, 1978, How to read better and faster (Indian Publisher:GOYL SAAB)
- Popper, K.R., 1959.The logic of scientific discovery, Hutchinson, London.

S E C O N D S E M E S T E R

Course No. : **AG201T, AG201P**

Title of the Course : **SEDIMENTOLOGY**

Name of the Course Teacher : **Prof. R.K. Sarmah and Dr. D. Bezbaruah**

Unit	Topic	No. of Lectures
I	1. Condition of sedimentation on the earth surface 2. Origin and occurrence of siliciclastic, carbonate sediments and other chemical/biochemical sedimentary rocks.	9
	3. Physical processes of sediment movement and sedimentation	5
	4. Sedimentary textures and structures. Use of textures and structures in interpreting depositional conditions.	5
II	5. Classification of sedimentary rocks: classification of conglomerate, sandstones, mudstone and carbonate rocks	10
	6. Sedimentary environments, facies association and models for major environments.	10
	7. Palaeocurrent analysis, heavy minerals analysis. Sedimentary Facies and Sequence Analysis.	7
III	8. Provenance of siliciclastic sedimentary rocks	4
	9. Diagenesis of sandstones, mudstone and carbonate rocks.	5
IV	10. Sedimentation and Tectonics: Classification of tectonic basins, sandstone composition and basin evaluation.	5
	11. Application of Stable isotopes in sedimentological studies	4
AG201P **V** **Practicals**	1. Megascopic and microscopic study of sedimentary rocks.	2 hours duration: one class per week
	2. Techniques of collections and preparation of sedimentary rocks.	
	3. Analysis of grain size, roundness and their graphic representation.	
	4. Heavy mineral separation and identification.	
	5. Palaeocurrent data analysis.	

Total Lectures + tutorials of 1 hour duration : 48
Practical classes of 2 hours duration : one per week
Total Credits : 4 { **Theory – 3 Credits**
: Practical- 1 Credit

Course Description:- Sedimentary rocks contain a wealth of information on past environments climate life forms, tectonics and sea level changes. These rocks are the storehouse of fossil fuels, ground water and many economic minerals.

Objectives:- There is a scope to examine the terrestrial and marine environments on Earth surface and how the depositional system and process imparts patterns and cycles on the basin fills. Reconstruction of past major events within a basin setup using different attributes of sedimentary rocks and their interpretation will be especially emphasized in the course.

Course delivery:-

The course will provide knowledge and skills to

(i) Describe and classify sedimentary rocks
(ii) Establish relationships of characteristics of the sedimentary rocks to physical, chemical and biological processes that formed them.
(iii) Construct facies associations and their genetic link to depositional system.
(iv) Understand the basin architecture and evolution through time and space
(v) To understand how these processes and products vary across scales i.e from grain to beds to facies to basins to Globe as a whole.
(vi) To be able to draw connection between sedimentary and other sub disciplines of the Earth science, other scientific disciplines in general and also everyday life in human society.

Outcome Expected:- This course will cover different theoretical and practical mainly the generation, transport and deposition of sediments and link theses processes with the depositional products and rock records

Suggested books:

- Blatt, H., Middleton, G.V. and Murray, R., 1992, Origin of Sedimentary Rock
- Carver, R.C. (Ed.), 1971, Procedures in Sedimentary Petrology
- Boggs, S.Jr., 1987, Principles of Sedimentology and Stratigraphy, Merill Publ. Co..
- Miall, A.D., 1990, Principles of Sedimentary Basin Analysis, Springer Verlag
- Reading, H.G. (Ed.), 1996, Sedimentary Environments and Facies, Blackwell Science2
- Collinson, J., Mountney, N.,Thompson, D., Sedimentary Structures,Terra Publishing, 3rd Edn.,2006.
- Nicholls, G.Sedimentology and Stratigraphy.Wiley-Blackwell,1999.
- Prothero, D.R.and Schwab, F.Sedimentary Geology:An introduction to Sedimentary Rocks and Stratigraphy, 2nd Edn.,W.H.Freeman,2003.
- Selley, R.C., Applied sedimentology, 2nd Edn., Academic Press,2000.
- Tucker, M.E. Sedimentary Petrology,3rd Edn., Blackwell Science,2001
- Lindholm Roy C. A practical approach to Sedimentology, 1980

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Name of the Teacher and Course : Prof. M.N. Dutta (COAL GEOLOGY)

Unit	Topic	Contact hours
I	Coal forming epochs, Origin, mode of occurrence and physical properties of coal.	3
	Chemical characteristics: Proximate and ultimate analyses	4
	Rank, Grade and Type of Coal	3
	Indian and International Classifications of Coal.	4
	Introduction to Coal Petrography	3
	Coal bed methane: a new energy resource. Maturation of coal and generation of methane in coal beds.	3
	Study of the coalfields of NE India and geological and geographical distribution of major coalfields in India.	4
II **(Practicals)** AG202P	1. Study of different ranks of coal in hand specimens- Megascopic characteristics.	**2 hours duration: one class per week**
	2. Proximate and Ultimate analysis of coal.	
	3. Identification of macerals under microscope.	

Total Lectures + tutorials of 1 hour duration : 48
Practical classes of 2 hours duration : one per week
Total Credits : 4 { **Theory – 3 Credits**
: Practical- 1 Credit

Course description:-
Coal is a combustible material and a primary source of heat and energy occurring abundantly in the earth's crust. In the normal course of events it is used as a fuel, for production of electrical power and as a part of the industrial processes to produce products such as steel and cement. Coal is, however, more versatile than this and has been able to provide alternative forms of energy from its by-product gases, through chemical treatment to become liquid fuel and by in-situ combustion to convert coal to liquid and gaseous products.

Objective:-
It is intended to provide the students the knowledge on the geology and the nature of coal, varying properties together with practice and techniques required in order to evaluate a coal in terms of its utilization. In addition, the alternative uses of coal as a source of energy is also addressed.

Course delivery:-
The course will be delivered through hands -on training both in the laboratory and coal mines as well as providing theoretical knowledge keeping in mind the energy scenario with an intention to assist the students to make decisions about coal.

Outcome expected:-
After thorough completion of the course, the students will definitely be able to explore and exploit coal resources required for various purposes like Industrial processes, fuel and energy generation. Further, this course will enlarge the field of research to the students towards the development of coal geology and proper utilization.

Suggested Books:

- Singh,R.M., Chandra, D. and Singh, M.P. (2000) : Text book of Coal (Indian context). 1st Edn., Tara Book agency, kamacha, Varanasi, 402P.
- Francis, W. (1961): Coal, its formation and compositions, Edward Arnold Publications, London, 806P.
- Raja Rao, C.S. (1981) (Ed): Coal fields of India. Bull. Series A, No. 45, V-I, Coal fields of North Eastern India, GSI.
- Ward, Colin.R. (1984): Coal Geology and Coal Technology, Blackwell Scientific Publication, 345P.
- Van Krevelen, D.W. (1961): Coal Typology-Chemistry-Physics-Constitution. Elsevier Publication, Amsterdam, 514P.
- Stach,E.,Mackowsky,M.Th.,Teichmuller,M.,Taylor,G.H.,Chandra,D.,Teichmuller,R., (1982): Stach's Textbook of Coal petrology, 3rd revised and enlarged Edition, Gebruder Borntraeger.Berlin, Stuttgart, 535P.
- Larry Thomas (2002): Coal Geology.John Wiley & sons Ltd. West sussex, England. 384P
- Chandra, D.,Chaudhury, S.G., Chaudhury, Nandita, (2007): Chandra's Textbook of Applied Coal Petrology. Jijnasa publishing house, Kolkata.408P.

Course No. **: AG203T, AG203P**

Title of the Course **: IGNEOUS AND METAMORPHIC PETROLOGY**

Name of the teacher and course **: Prof. T. K.Goswami (IGNEOUS PETROLOGY)**

Unit	Topic	No. of Lectures
I	1. Definition of Magma, Constitution of Magmas, Generation of Magmas, source rock composition: upper mantle and lower crust, evolution of magma	4
	2. Application of major and trace elements in petrogenesis, construction of variation diagrams, classification of trace elements, Rare earth elements and their applications to petrogenesis. 3.Classification of magmatic rocks-based on fabric, field relations, mineralogical and modal, and whole rock compositions, IUGS classification of plutonic, hypabyssal and volcanic rocks, Irvine-Baragar classification of volcanic rocks,classification of basalt, igneous rock names, chemical discriminants of rock types. MELT programme.	4
	4. Crystallization of basaltic and granitic magmas: Mid oceanic ridge volcanism, continental flood basalts, Deccan basalts, basalt magmatism associated with subduction zone.	4
II	5. Heat flow and magma generation: (mantle plume /hot spots; large igneous provinces). Role of fluids in magma generation. Concept of mantle metasomatism and enrichments in lithospheric peridotites	6
	6. Igneous rocks of oceanic regions: Oceanic spreading ridges and related basaltic rocks, mantle plumes and oceanic island volcanic rocks, plume heads and flood basalt plateau lavas, arc magmatism, oceanic island arcs. Other associations: Igneous rocks associated with convergent plate boundaries, continental flood basalt and large igneous provinces,large layered igneous complexes, continental alkaline rocks, ultra-alkaline and silica poor alkaline rocks, alkaline cratonic associations, ophiolite, granites and granites, continental rift associations.	6
III AG203(P) **(Practical)**	1. Study of the Mineralogy & Textures of Igneous rocks	**2 hours duration: one class per week**
	2. Determination of modal composition of igneous rocks.	

Course description

Igneous Petrology deals with the magmatism in regard to origin, ascent and emplacement and its association in relation to diverse tectonic settings. It also deals with the thermodynamics of magmatic crystalisation, phase equilibrium, interpretation of textures in terms of rate of nucleation and crystal growth. It also deals with the generation of large igneous bodies in terms of space and time. In addition

to, petrology and petrogenesis of major igneous rock types are also discussed. It also describes the plume magmatism and hot spots.

Objectives

The course is designed so that students are familiarised with generation and mode of occurrence of igneous rocks. Furtherv, the filed characteristics of common igneous rocks and igneous suits in different tectonics settings are taken in to consideration.

Course delivery

The course is delivered though a series of teaching modules and makes students accustomed with the common igneous suits, evolutionary trends. Further, characteristics for classification and description of common igneous rocks in the field and in thin sections are also emphasised.

Outcome expected

The outcome expected through the course is to produce students with sound knowledge of igneous petrology and its applicability in different sectors of the mineral exploration. Further, the course content is made up to date so that students don't face any difficulty in preparing for the various competitive examinations.

Name of the teacher and course : Prof. P. Bhattacharyya (METAMORPHIC PETROLOGY)

Unit	Topic	No. of Lectures
I	1. Metamorphism, Types of Metamorphism.	2
	2. Equilibrium in metamorphism, metamorphic reactions the free energy in metamorphic reactions.	2
	3. Metamorphism and Plate Tectonics.	2
	4. Metamorphic differentiation	2
	5. Zone and Facies concept in Metamorphism	2
	6. Metamorphic Paragenesis, graphical representation of ACF, AKF and AFM diagrams in the determination of mineral paragenesis	4
II	7. Metamorphism of argillaceous sedimentary rocks and mafic igneous rocks.	3
	8. Metasomatism : Types of metasomatism.	2
	9. Geothermobarometry, Compositional zoning and P-T path.	4
	10. Introduction to relevant softwares.	1
III (Practical) AG203P	1. Study of the Mineralogy & Textures of Metamorphic rocks.	**2 hours duration: one class per week**

Course Description:- Metamorphic Petrology deals with the metamorphism of rocks, its type, environment and its relation with geological settings along with plate tectonics. Petrology and Petrogenesis of major metamorphic rock types will be discussed. In addition, thermodynamic consideration and application will be discussed to understand the geochemistry leading to Petrology and the Geothermometry and Geobarometry of the rocks.

Objective:- The course is designed to make the students familiarized with recrystallisation, structural readjustment and metamorphic reactions in rocks. Also field characteristics of common metamorphic rocks to different geological and tectonics settings are taken in consideration.

Course delivery:-The course will be delivered with different teaching modules. The course will also be delivered through hands-on training in the field and laboratory supported by theory classes.

Outcome expected:- At the end, students will have sound knowledge of metamorphic petrology and its applicability in different sectors including mineral exploration. Further, students will be made ready for Research works as well as preparing themselves for various competitive examinations.

Total Lectures + tutorials of 1 hour duration : 48
Practical classes of 2 hours duration : one class per week
Total Credits : 4 Theory – 3 Credits
Practical- 1 Credit

Suggested Books:

Igneous Petrology

- Best, M.G, 2002. Igneous Petrology, 2nd Edition, Blackwell Publishers
- Bose, M.K., 1997. Igneous Petrology, World Press, Kolkata.
- Cox, K.G, Bell, J.D. and Pankhurst, R.J., 1993. The Interpretation of Igneous Rocks. Champman & Hall, London.
- Hall, A., 1997. Igneous Petrology, Longman.
- LeMaitre, R.W., 2002. Igneous Rocks. A Classification and Glossary of Terms, Cambridge University Press.
- McBirney, 1994. Igneous Petrology, CBS Publishers, Delhi.
- Phillpotts, A.R., 1994. Principles of Igneous and Metamorphic Petrology, Prentice Hall of India.
- Philpotts, A.R., Petrography of Igneous and metamorphic rocks under the microscope, Prentice Hall.
- Vernon;: R. H., 2004. A Practical Guide to Rock Microstructure,Cambridge University Press.
- Winter, J.D., 200 I. AnTntroduction to Igneous and Metamorphic Petrology, Prentice Hall. l l. Yardley, B.W., 1989. An Introduction to Metamorphic Petrology,Longman.

Metamorphic Petrology

- Philpotts, A.R. & Ague, J.J. 2009. Principles of igneous and metamorphic petrology. Cambridge University Press.
- Bucher K. and Martin F. 2002. Petrogenesis of Metamorphic rocks. Springer-Verlag Publication.
- Vernon R. H. and Clarke G. L. 2008. Principles of Metamorphic Petrology.
- Cambridge publication.
- Spears F. 1993. Metamorphic Phase Equilibria and Pressure-Temperature-Time Paths. AGU publication
- John D. Winter 2001. An Introduction to Igneous and Metamorphic Petrology.
- Prentice Hall Inc

Course No. **: AG204T, AG204P**

Title of the Course **: GEOMORPHOLOGY AND SEISMOLOGY**

Name of the teacher & course **: Dr. Ratamali Machahary (GEOMORPHOLOGY)**

Unit	Topic	No. of Lectures
I	Basic concept of Geomorphology, Control of geomorphological features by geological structure, lithology & Climate.	1
	Physical, chemical, and biological processes in weathering, Soil profiles and nomenclature of horizons, Classification of soils, Role of soil in geomorphology.	3
	Mass movement and hillslope evolution, Classification of mass movements.	2
	Fluvial system, drainage basin and networks, River and channel geometry, Longitudinal profile of river, Fluvial erosion, transportation and depositional processes and related landforms.	3
	Morphometric analysis of basins. Concept of basin morphometry. Laws of drainage composition. Linear aspects aerial aspects , relief aspects	2
II	Geomorphic Landforms: Glaciers Types of glaciers, Movement of glacier. Glacial landforms	2
	Formation of deserts, desert characteristics Eolian processes and landforms.	2
	Energitics of shore-zone processes – waves, tides and currents. Coastal landforms. Coastal submergence and emergence-shoreline development.	2
	Quaternary geomorphology, Cycles of climatic changes and landforms.	2
	Geomorphological subdivisions of Indian subcontinents, Geomorphology of lndogangetic plain, Peninsula, and Brahmaputra Valley.	3
	Tectonic Geomorphology: Concept, topographic markers and geomorphic indices of active tectonics. Active tectonics and rivers	2
III (Practical) AG04P	Study of geomorphic models and topographic maps	**2 hours duration: one class per week**
	Measurement of morphometric parameters for drainage basins.	
	Interpretation of structures from contour maps	
	Longitudinal profile of a river	
	Slope analysis	

D**escription:**

Geomorphology is the study of surface features of earth's surfaces, description of landforms, their origin, development and the processes that caused their development. The course is designed to provide the basic knowledge and tools to understand the earth's surfacial processes including erosion and deposition by water, ice, wind, and gravity; physical and chemical weathering; mass wasting and hill slope evolution; soil development, and fluvial land form evolution.

Objective:

The main objective of the course is to introduce students to basic concepts of landforms and the processes that produce and modify them. The main aim of the course is the understanding of natural processes, the mechanics of geomorphic processes and the relationships between properties of earth materials and the forces applied to them by gravity, wind, ice, water, waves and humans.

Course delivery:
The course is taught through series of teaching modules focusing on the course content. Practicals are taught in the Geomorphology laboratory with required instruments, SoI topomaps, other maps and data focusing on each and every student so that they get hold of the knowledge of different techniques used for landform analysis.

Expected outcome:
At the end of semester students will be able to identify the major and minor landforms on the Earth's surface and interpret the processes responsible for their genesis. They will have knowledge of different techniques to analyse the landforms.

Suggested Books (Geomorphology)

- Bloom, A.L., 2003, Geomorphology – A systematic analysis of late Cenozoic landforms - Pearson Education
- Singh, S., 2016, Geomorphology – Pravalika Publication Allahabad
- Thornbury, W.D., 2002, Principles of Geomorphology – CBS Publishers & Distributions Pvt. Ltd.
- Spark, B.W., 1986, Geomorphology – Longman scientific & Technical
- Dayal, P., 2001, A textbook of Geomorphology – Shukla Book depot
- Burbank, D.W. and Anderson, R.S., 2008, Tectonic Geomorphology – Balckwell science

Name of the teacher & course : Dr. Geetartha Dutta (Seismology)

Unit	Topic	**No. of Lectures**
I	Introduction to seismology; Earthquake and its effects; Elastic rebound theory; Classification of earthquakes;	**4**
II	Seismicity and seismotectonics of India; Magnitude scales; Intensity scales;	**6**
III	Theory of elasticity; Generalized Hooke's law; Different types of elastic waves; Seismometers; Analysis of seismograms; Seismic networks and arrays; Earthquake prediction.	**6**

Description:-Seismology is the study of the causes, effects and risk assessment of earthquakes. It also studies the generation and propagation of various types of seismic waves generated by earthquakes. This course includes the study of theories that explain the causes of earthquakes, as well as the study of how seismic waves are recorded and analyzed.
Objective: The course is designed to provide students the basic concepts of seismology, along with some practice in analyzing seismological database.
Course delivery: The course is delivered through a series of class lectures and exercises.
Outcome expected: Students, after completing this course, are expected to be well prepared to pursue future studies and research in the field of seismology.

Books Suggested:

- Shearer, P.M. (2009).*Introduction to Seismology*. Cambridge University Press.
- Lowrie, W. (2007). *Fundamentals of Geophysics*. Cambridge University Press.
- Scholz, C.H. (2002). *The Mechanics of Earthquakes and Faulting*. Cambridge University Press.
- Bullen, K.E. and Bolt, B.A. (1985). *An Introduction to the Theory of Seismology*. Cambridge University Press.
- Gubbins, D. (1990). *Seismology and Plate Tectonics*. Cambridge University Press.

Total Lectures + tutorials of 1 hour duration : 48
Practical classes of 2 hours duration : one class per week
Total Credits : 4 (**Theory – 3 Credits**, **Practical- 1 Credit**)

Course No. **: AG2D1T, AG2D1P**

Title of the Course **: ROCK MECHANICS**

Name of the teacher **: Dr. D. Bezbaruah**

Unit	Topic	No. of Lectures
I	Definition, importance and scope of the subject. Analysis of stress and strain at a point; Mohr's circle of stress and strain; stress field	
	Physical and mechanical properties of rocks; compressive, tensile, shear and triaxial strength of rock;	
II	Behaviour of rock under stress/strain and creep in rocks rheological models. Theories of rock failure: Coulmb-Navier Criteria, Griffiths criteria, Mohr's criteria. Stress concentration around an opening. Rock bursts and bumps.	
	Subsidence - causes, prediction, monitoring and prevention.	
	Determination of in-situ stresses. Instrumentation and monitoring of stability of structure in rocks.	
	Stabilization of weak and fractured ground - grouting and shortcreting	
III **AG2D1P** **Practical**	Direct and indirect methods of determination compressive, tensile, shear and triaxial strength of rock; modulus of elasticity and Poisson's ratio; dynamic modulus of elasticity; porosity of rock; load cell, extensometer and convergence meter.	**2 hours duration: one class per week**

Total Lectures + tutorials of 1 hour duration **: 48**
Practical classes of 2 hours duration **: one class per week**
Total Credits **: 4** **Theory – 3 Credits**
Practical- 1 Credit

SUGGESTED BOOKS:

- Introduction to Rock Mechanics by R.E.Goodman, John Wiley & Sons.
- Engineering in Rocks for Slopes, Foundation and Tunnels, Editor T.Ramamurthy, Prentice Hall India Pvt. Ltd.
- Fundamentals of Rock Mechanics, Fourth Edition, by Jaeger, Cook and Zimmerman, Blackwell Publishing.
- Rock mechanics and the design of structures in rock, L. Obert and Wilbur I. Duvall, John Wiley & Sons, Inc. A joint venture by IISc and IITs, funded by MHRD, Govt of

Course No. : **AG2D2T, AG2D2P**

Title of the Course : **Applied Paleopalynology**

Name of the Teacher : **Dr. D. Bhuyan**

Unit	Topic	No. of Lectures
I	1. Introduction to Palynology, History, definition and scope.	2
	2. Pollen and spore structure, basic terminology.	2
	3. Introduction to pollen morphology, ornamentation and classification. Principles of pollen analysis; production, dispersion, sedimentation and preservation.	4
II	4. Identification of spores, gymnosperm and angiosperm pollens. Quantitative analysis of fossil spore and pollens.	3
	5. Taphonomy of spore and pollens	2
	6. Dinoflagellates	2
	7. Significance of other palynomorphs/ microfossils (Algae, Diatom, Cocolith, Radiolaria, Microforaminifera and Acritarchs) and their identification.	4
	8. Stratigraphic Palynology - Palynostratigraphy. Application of palynology in Sequence stratigraphic study	3
	9. Differential sorting of palynomorphs into sediments: Palynofacies	3
III	10. Palynodebris : their analysis and application	3
	11. Statistical analysis in palynology. Pollen diagrams: construction and interpretation.	3
	12. Application of palynology in petroleum exploration. Organic maturation indices. Thermal maturity of palynomorphs and palynodebris and its application in source rock assessment. ColourIndex(CI), Thermal Alteration Index (TAI).	4
	13. Application of palynology in Paleoclimate, Paleogeography and Paleoecological reconstruction.	3
IV Practical **AG2D2P**	1. Laboratory techniques of palynology.	**2 hours duration: one class per week**
	2. Statistical analysis. Pollen diagrams: construction and interpretation.	
	3. Colour Index(CI) and Thermal Alteration Index (TAI) determination of palynomorphs and palynodebris	

Total lectures + tutorial of 1 hour duration : **48**

Practical classes of 2 hours duration : **one per week**

Total Credits : **4** (**Theories – 3 Credits**, **Practical- 1 Credit**)

Palynology plays an important role in geological sciences, providing the most effective method of exploring hydrocarbons; establishing biostratigraphy and sequence biostratigraphy; reconstructing paleoecology, paleobigeography, evolutionary history; interpreting paleoenvironment and climate change and dating sedimentary sequence.

Objective: The course is designed to provide the students a detailed coverage of the important palynological groups and to focus on the contribution of palynology in understanding Earth Science.

Course delivery: The course is delivered through a series of taught modules focusing on the key palynological groups and their applications.

Outcome expected: The course is mainly designed to prepare students for work in the geological and related service sector especially in the petroleum sector with a knowledge of palynology in details. The skills acquired by the students will also provide a strong foundation for those wishing to undertake further postgraduate study towards the award of a Ph D in palynology. The students will be prepared for teaching professions also.

Suggested Books:

- Paleopalynology: Alfred Traverse
- Sedimentary Organic Matters: Organic facies and Palynofacies - R Tyson
- Sedimentation of Organic Particles: Alfred Traverse, Cambridge University Press
- Palynology, Volumes 1-4, American Association of Stratigraphic Palynologists., 1977
- Aspects of Palynology: An Introduction to Plant Microfossils in Time, Robert Haydn Tschudy, Richard Albert Scott, Wiley-Interscience, 1969
- Palynology, principles and applications: Volume 1, J. Jansonius, Duncan Colin McGregor, American Association of Stratigraphic Palynologists Foundation, 1996
- Palynology and its application to geomorphology: Moss, Patrick T. (2013). Palynology and its application to geomorphology. In John F. Shroder, A. D. Switzer and D. M. Kennedy (Ed.), *Treatise on geomorphology* (pp. 315-325) San Diego, CA, United States: Academic Press. doi:10.1016/B978-0-12-374739-6.00395-X
- An Introduction to Pollen Analysis: Erdtman, G., 1954 (1943).
- Sporopollenin, Dinoflagellate Cysts: Their Morphology and Interpretation: Evitt, W. R., 1985
- Pollen Grains: Wodehouse, R. P., 1935, McGraw-Hill, New York. (Reprint by Hafner, New York, 1959).
- A Glossary of the Terminology Applied to Dinoflagellates, Acritarchs and Prasinophytes, with Emphasis on Fossils: Williams, G. L.et al., 2000, 3rd Ed., Amer. Assoc. Strat. Palynol. Contrib. Ser.37.
- The Biology and Evolution of Fossil Plants: Taylor, T., and Taylor, E. L., 1993, Prentice Hall, Englewood Cliffs, New Jersey.

Course No. : **AG2D3T**

Title of the Course : **Geostatistics and Rock Physics**

Name of Teacher : **Dr. Geetartha Dutta**

Unit	Topic	No. of Lectures
I	Introduction to geostatistics: Basics of geostatistics; Univariate distribution; Monte Carlo simulation; Measures of distribution center; Measures of spread; Concept of stationarity; Prior and posterior distribution; Probability theory; Different types of distributions; Bayes rule; Variograms; Kriging.	10
II	Geostatistical simulation: Geostatistical simulation of reservoir properties: facies, porosity, permeability; Two-point algorithms: sequential Gaussian simulation (SGSIM), sequential indicator simulation (SISIM), sequential indicator co-simulation (COSISIM); Experimental variogram; Conditioning to hard and soft data; Multiple-point algorithms: single normal equation simulation (SNESIM) and direct sampling (DS); Training image.	15
III	Introduction to rock physics:Basics of rock physics; Rock physics, petrophysics and rock mechanics; Different types of waves; Wave velocities and moduli; Dependence of wave velocities on saturation and pressure; Stress and strain; Elasticity.	10
IV	Effective medium theories: Theoretical models; Contact theories and inclusion models; Bounding methods; Voigt and Reuss bounds; Hashin-Shtrikman bounds; Wyllie time average; Bounding average method; Models for pore deformation; Estimating the dry rock modulus; Differential Effective Medium (DEM) approximation.	14
V	Rock physics concepts: Fluid substitution; Gassmann's relations; Velocity, porosity, clay relations; Carbonates; Fluid flow and permeability; Darcy's law; Kozeny-Carman relation; Partial saturation: patchy and uniform saturation; Relative permeability; AVO: Shuey's approximation and Aki-Richard's approximation; Vp-Vs relations; Anisotropy; Fractures.	15

Total Lectures of 1 hour duration : 64
Total Credits : 4

Description:- Geostatistics is the branch of statistical science that studies spatial/temporal phenomena and takes into account spatial relationships to model possible values of variables at unobserved, unsampled locations or time. Geostatistics plays a big role in the modeling of the earth's subsurface as there usually exists a lot of uncertainty even after collecting good datasets. Rock physics deals with studying the relationships between the elastic properties of rocks as seismic waves propagate through them, and the geological properties that are of interest in subsurface modeling and characterization.
Objective: The course is designed to provide students the fundamental concepts of geostatistics and rock physics, along with some practice in using various geostatistical simulation algorithms and implementing some rock physics models.
Course delivery: The course is delivered through a series of class lectures and hands-on exercises using SGEMS and Matlab.
Outcome expected: Students, after completing this course, are expected to be well prepared to use various geostatistical simulation techniques in subsurface modeling as well as apply various rock physics concepts and models in reservoir characterization. This will help students in their research if they pursue a Ph.D in the future. This course will also be useful for undertaking projects in various industries including the oil and gas, mineral and mining industries.

Suggested Books:

- Avseth, P., Mukerji, T. and Mavko, G. (2005).*Quantitative Seismic Interpretation*. Cambridge University Press.
- Mavko, G., Mukerji, T. and Dvorkin, J. (2009). *The Rock Physics Handbook*. Cambridge University Press.
- Saxena, V., Krief, M. and Adam, L. (2018).*Handbook of Borehole Acoustics and Rock Physics for Reservoir Characterization*. Elsevier.
- Caers, J. (2011). *Modeling Uncertainty in the Earth Sciences*. Wiley.
- Remy, N., Boucher, A. and Wu, J. (2009). *Applied Geostatistics with SGeMS*. Cambridge University Press.
- Mariethoz, G. andCaers, J. (2015). *Multiple-Point Geostatistics: Stochastic Modelingwith Training Images*. Wiley.
- Doyen, P. (2007). *Seismic Reservoir Characterization: An Earth Modelling Perspective*. EAGE.
- Dubrule, O. (2003).*Geostatistics for Seismic Data Integration in Earth Models*. SEG.
- Caers, J. (2005). *Petroleum Geostatistics*. SPE.
- Deutsch, C.V. (2002). *Geostatistical Reservoir Modeling*. Oxford University Press.
- Goovaerts, P. (1997). *Geostatistics for Natural Resources Evaluation*. Oxford University Press.

Course No. : **AG2G1T, AG2G1P**

Title of the Course : **Essentials of Earth Science**

Name of the teacher : **Faculties of Applied Geology**

UNIT	TOPIC	Name of the faculty	Contact hours L + T
I	Mineral definition, types and examples, Rocks and the rock cycle, Vulcanicity and igneous rocks, Sedimentary rocks and Metamorphic rocks.	RKS PB	8
II	Folds, shear zones, faults and lineament	TKG	8
	Plate tectonics, Distribution of earthquakes, Evolution and modification of sedimentary basins, Deposits related to climates.	PK DBB	8
III	Fossils, fossil fuels, source, migration, and reservoirs and trapping of fossil fuels. Important oil fields of India and NE India	KDK DB	8
	Economic minerals / Water Resource	DM/MND/ UG	8
IV	Tectonic geomorphology. Geomorphic indices of active tectonics, Active tectonics and rivers, Short-term deformation and geodesy, Paleoseismology, rates of erosion and uplift, tectonic activities and mountain fronts, Fault scarps.	DBB RM	10
V	Gaia hypothesis; Greenhouse earth, Icehouse earth, BLAG hypothesis, Monsoon circulation, Insolation control of ice sheets, Milankovitch Theory, Orbital scale changes in Carbon dioxide and Methane, The Last Glacial Maximum, Millenial oscillations in climate. Climatic changes during the last 1000 years	SKL	10
TOTAL			**48**
VI Practical	Identification of rocks and minerals Identification of geomorphic features Identification of fossils (Mega and Micro)	**Two hours duration: one class per week**	

Total classes + tutorial of 1 hour duration : **48**
Practical classes of 2 hours duration : **one per week**
Total Credits : **4** **Theories – 3 Credits**
Practical- 1 Credit

Suggested books:

- Ruddiman, W.F., Earth's Climate: Past and Future, Freeman and Company, 2013.
- Haakon Fossen, 2010. Structural Geology, Cambridge university press.
- Blyth, F.G.H., Fritas, M.H. de, 1984. A Geology for Engineers, Elsevier.
- Allen, P.A., Allen, J.R., 2005. Basin Analysis, Principles and Applications, 2nd edition, Blackwell Publishing
- Burbank, D.W., Anderson, R.S., 2001. Tectonic Geomorphology, Blackwell.
- A.I. Levorsen, Geology of Petroleum (2nd Edition)

THIRD SEMESTER

Course No. **: AG301T, AG301P**

Title of the Course **: Geological & Geochemical Exploration**

Name of the teacher and course **: Prof. R. K. Sarmah (Geological Exploration)**

Unit	Topic	No. of Lectures
I	1. Mineral Exploration and Exploration Geology	3
	3. Exploration Philosophy and Principles. Stages and norms of exploration. Geological techniques and procedures of exploration.	3
	4. Geological criteria and guides to mineral search. Geological mapping phases and types. Sampling methods and ore reserve estimation.	6
II	5. Exploration of important economic mineral deposits. Exploration case histories.	6
	6. Study of geological maps and sections, stratigraphic columns, structure contour maps, isopach maps, facies maps.	3
	7. Exploratory drilling – brief reviews of different drilling methods, planning, selection of sites, core logging and records.	3
	8. Geological documentation of exploratory works	**2 hours duration: one class per week**
III Practical AG301P	1. Preparation of geological maps and cross-section.	
	2. Construction of sub-surface maps using exploration data.	
	3 Map exercises based on geological exploration methods.	

SUGGESTED BOOKS:

- Charles Moon, Charles J., Whatley Michael K.G. and Evans K.M.; Introduction to mineral exploration, Blackwell publishing. 2006.
- Haldar S.K.; Mineral exploration, principle and exploration.
- Kuzbart M. and Bohmer M.; Prospecting and exploration of mineral deposits. Elsevier Sci. U.V. Company. 1978.
- Levinson,A.A. 1974; Introduction to exploration geochemistry, Applied Pub., Calgary
- Peters, W.C. 1978; Exploration and mining gelogy. John Wiley & Sons, N.Y.
  David, M. 1977; Geostatistical ore reserve estimation. Elsevier Pub.,

Name of the Course Teacher and Course: Mr. Pranjit Kalita and Ms. Pallabi Borkakoty

(Geochemical Exploration)

Unit	Topic	No. of Lectures	Name of the Teacher
I	1. The earth in relation to the Universe. Earth as Physico-chemical system. Geochemical cycle. The Geochemical classification of elements. Geochemical evolution of the earth.	4	Mr. Pranjit Kalita
	2. A short account of geochemical processes in relation to magmatism, sedimentation and metamorphism.	3	
	3. Special properties of trace and REE elements.	2	
	4. Radioactive isotopes and their application to geochronology and petrogenesis.	2	
	5. Stable isotopes and their application to earth system processes.	1	
II	6. Geochemistry in Mineral exploration. Geochemical dispersion, mobility, association of elements.	2	Ms. Pallabi Borkakoty
	7. Various prospecting methods for geochemical rock sampling, soil, water, drainage, biogeochemical and geobotanical surveys and a brief description of geochemical anomalies developed in it.	6	
	8. A short account of geochemical aspects of coal and petroleum.	2	
	9.Geochemical methods of hydrocarbon source rock analysis	2	
III Practical AG301P	1. Techniques of trace element analysis in geochemical studies, preparation, decomposition, separation and estimation of various elements present in geological samples.	**2 hours duration: one class per week**	Ms. Pallabi Borkakoty
	2. Exercise on sampling, estimation of background and threshord value. Statistical analysis of sampling data.		
	3. Interpretation of datas gathered from soil sampling and drainage survey. Preparation of different types of interpretation maps.		
	4. Follow up proceedures based on data of various geochemical surveying technique.		

Total Lectures + tutorials of 1 hour duration : 48
Practical classes of 2 hours duration : one class per week
Total Credits : 4 **Theory – 3 Credits**
Practical- 1 Credit

Course description:- Geochemical Exploration plays an important role in geological sciences. Based on the knowledge and basic theory of geochemistry it introduces the geochemical principle method, technology, application conditions, the effects of exploration, geochemical anomaly its evaluation and interpretation. It also deals with the geochemical aspects of coal and petroleum, explains the geochemical methods used for hydrocarbon source rock analysis.

Objective:- The aim and objective of this course is to enable the students to systematically master the basic principles and methods of exploration geochemistry so that they can apply the effectiveness of this method and know the techniques of data processing, geochemical mapping, detecting geochemical anomaly and also their interpretation.

Course delivery:-The course is delivered through a series of teaching modules focusing on the basic principles and methods of geochemistry and their application in various fields.

Outcome expected:-The course is mainly designed as to make the students deeply understand the use of geochemistry in exploration purpose and also to make the students really be able to use it in practice.

Suggested Books:

- .Masson B. & Moore C., Principles of Geochemistry.
- .White W.M., Geochemistry.
- Rollinson H.R., Using Geochemical Data.
- Winter J.D., Principles of Igneous and Metamorphic Petrology,
- Haweks H. E. and Webb J. S., Geochemistry in Mineral Exploration.

Course No. : **AG302 T**

Title of the Course : **Hydrogeology**

Name of Course Teacher : **Prof. U. Goswami**

Unit	Topic	No. of Lectures
I	Definition of Hydrology and its relation with other sciences. Hydrologic cycle. Origin, occurrence and distribution of subsurface waters. Porosity and different types of pore spaces in rocks. Aquifer-its definition and different types.	6
	Groundwater levels and fluctuations: various causes of water level fluctuations.	4
	Dynamics of subsurface water: Darcy's law and its range of validity, steady and unsteady flow. Permeability/Hydraulic conductivity, specific yield, transmissivity, storage coefficient - their definitions, concepts and methods of determination.	6
	Well hydraulics: Concepts of drawdown, cone of depression, specific capacity, specific drawdown and boundary conditions, Determination of aquifer characteristics from pumping tests.	7
II	Occurrence and distribution of groundwater in fractured and karstic regions. Groundwater provinces of India with special reference to Brahmaputra valley.	3
	Groundwater investigation: Geological, hydrogeological and geophysical approaches; Groundwater inventory.	4
III	Water well drilling, design and construction. Hydrogeological studies in drilled wells.	6
	Basic concepts of groundwater management – equation of hydrologic equilibrium, groundwater basin, groundwater budgeting, safe yield and overdraft. Artificial recharge of groundwater and water logging.	5
	Fresh and saline water relationship in coastal areas: Ghyben-Herberg principle and its modification. Prevention and control of sea water intrusion.	3
IV	Quality of ground water: Graphic representations of chemical analysis data of water samples. Quality criteria for drinking and irrigation purposes. Water contaminants and pollutants: problems of arsenic and fluoride in North-East India.	4
	Preparation and Interpretation of well hydrographs.	**2 hours duration:**

III Practical AG302P	Preparation, interpretation and study of water table and piezometric surface maps.	**one class per week**
	Preparation of hydrogeological sections.	
	Determination of aquifer characteristics from the analysis of Aquifer Performance Test (APT) data with the help of Theis and Jacob methods.	
	Graphic representation of groundwater chemical analysis data.	
	Hydrogeological properties of aquifer materials from textural analysis: Determination of effective size, uniformity coefficient and sorting coefficient from grain size analysis data.	
	Numerical problems.	

Total Lectures + tutorials of 1 hour duration : 48
Practical classes of 2 hours duration : one class per week
Total Credits : 4 **Theory – 3 Credits**
Practical- 1 Credit

Course Description: Hydrogeology is a part of geology that deals with the occurrence, distribution, movement and quality of water beneath the Earth's surface, commonly known as groundwater which occur in aquifers. Hydrogeology requires a multidisciplinary approach involving many other sciences: geology, surface hydrology, climatology, geography, physics, chemistry, biology, and more.

Objectives: Groundwater is a renewable resource; whatever amount of groundwater is extracted from the subsurface reservoir, it is normally replenished again annually. Accurate assessment of groundwater together with proper management programs will ensure sustained supply of this important resource. The paper on Hydrogeology aims to provide basic concepts for assessment, development and management of groundwater resources.

Course Delivery: The course is delivered through a series of taught modules comprising theory, fieldwork and laboratory methods.

Outcome Expected: The 21st century now faces great challenges, one of which is to provide potable drinking water to all inhabitants of the planet. Due to runaway population growth and pollution, fresh water is becoming rarer and rarer. It is a vital resource that we must learn to locate, manage and distribute judiciously. The course is mainly designed to prepare students in such a way that they acquire the requisite skills for exploration, development and management of groundwater along with the basics for good water well design.

Suggested Books:

- Groundwater Hydrology (2nd Edn) - D.K. Todd, *John Wiley & Sons, New York*
- Ground Water - C.F. Tolman, McGraw Hill Book Co., New york
- Hydrogeology - Davis, S. N., and DeWiest, R. J. M., *John Wiley & Sons, New York*
- Applied Hydrogeology (Second Edn) - C. W. Fetter,. *CBS Publishers & Distributors, Delhi, India.*
- Groundwater Resource Evaluation - *W.C. Walton* (1970), *McGraw-Hill Inc.*
- Ground Water - *H.M. Raghunath* (1983), Wiley Eastern Ltd., New delhi
- Ground Water Assessment Development and Management - *K.R. Karanth,* (1987), *Tata McGraw-Hill, New Delhi*
- Field Hydrogeology - *R. Brassington*, (2007), 3rd Edn., *John Wiley & Sons, Ltd*.
- Hydrogeology Principles and Practice - *K. M.Hiscock*, (2005), *Blackwell Publishing*
- Introduction to Ground Water Hydrology - R.C. Heath and F.W. Trainer, John Wiley & Sons, New York.

Course No. **: AG303(T&P)**

Title of the Course **: Engineering Geology & Remote Sensing**

Name of the teacher and course **: Dr. D. Bezboruah (Engineering Geology)**

Unit	Topic	No. of lectures
I	1. The role of Engineering Geology in civil construction. Stages of engineering geological investigation for civil engineering projects.	2
	2. Engineering properties of intact rock and rock mass. 3. Engineering properties considered for rock classifications. Engineering classification of rocks – intact rock classification and rock mass classification.	6
	4. Engineering properties for soil. Universal Soil Classification System (USCS).	3
II	5. Geological considerations for selection of sites for construction of dams, reservoirs, tunnels, roads and bridges. Support Design for underground excavation and slope	6
	6. Mass movements with special emphasis on landslides and causes of hill-slope instability.	2
	7. Geological considerations for evaluation of foundation of buildings.	2
	8. Earthquakes and seismicity, seismic risk zones of India. Aseismic design of buildings.	3
III Practical AG303P	**1.** Study of site-maps of important engineering structures such as dams and tunnels**.**	**2 hours duration: one class per week**
	2. Exercises on engineering-geological site problems.	

Objective :- To develop students skills for using knowledge of geology for economic construction of civil engineering project.

Outcome expected: To work with civil engineer by communicating knowledge of geology for safe and economic design and construction of civil engineering project.

Suggested Books

(Engineering Geology)

- Krynine, D.P.Judd,W.R. "Principles of Engineering Geology and Geotectonics" CBS Publications & Distributors 2001
- Bell, F.G. "Fundamentals of Engineering Geology" Elsevier 2007
- Singh, B.& Goel, R.K ., `Rock mass classification: A practical approach in civil Engineering', Elsevier 1999
- Gokhale, K.V.G.K. "Principles of Engineering Geology" B.S. Publications
- Johnson, R.B. & Degraff, J.V."Principles of Engineering Geology" Wiley

Name of Teacher and Course : Dr. R. Machahary (Remote Sensing)

Unit	Topic	No. of Lectures
I	Concepts and fundamentals of aerial photography and remote sensing. Electromagnetic spectrum. Physics of remote sensing, Spectral reflectance curve.	2
	Aerial photography: Photographic flight planning, Aerial camera, film and filters.	3
	Geometric characteristics of Aerial photographs : Geometry of vertical aerial photographs. Terminology. Tilt and image displacement. Stereoscopic parallax, stereoscopy and vertical exaggeration	3
	Aerial photographs in field mapping and preparation of photogeological maps.	2
	Working principles and use of simple photogrammetric instruments. Methods of quantitative determination of height, dip of bed, stratigraphic thickness and throw.	3
II	Remote sensing sensors and platforms. Remote sensing data products, Concept of Digital Image Processing - Geometric and radiometric corrections.	2
	Principles of photo interpretation. Elements of photo interpretation : Scale, tone, colour, texture, pattern, shape, size. Drainage patterns, Drainage anomaly	2
	Applications: Photogeological Techniques in lithological and structural interpretation. Application of photogeological interpretation in mineral exploration, engineering geology and ground waters studies. Geological features identification from Remote Sensing Techniques.	3
	Space Missions : Global and Indian space mission LANDSAT, METEOSAT, SEASAT. SPOT, IRS.	2
	GIS – Concepts, components, data formats and structure.	2
III Practical AG303P	Pocket Stereoscope- stereo-text and study of different types of aerial photos.	**2 hours duration: one class per week**
	Mirror Stereoscope: Orientation of stereomodel under mirror stereoscope. Tracing of details from stereopairs.	
	Determination of photo scale.	
	Determination of Height: Using single photograph and with mirror stereoscope from stereopairs.	
	Study of multispectral data and Thermal Imagery.	

Description

Earth observation form distance through remote sensing instruments has provided a vantage means of monitoring the earth surfaces. Remote sensing is the science and art of acquiring information about the earth surface without actually being in contact with it. This is done by sensing and recording reflected or emitted energy and processing, analysing and applying the information. The course introduces remote sensing concepts and techniques used in understanding the earth system.

Objective:

The main objective of the course is to introduce the student to attain foundation knowledge and understanding of the physical principles of remote sensing, its capabilities and limitations, a sense of the diversity of applications, and the relationship between these and a variety of sensors, platforms, and systems. Also to gain basic experience in the hands on application of remote sensing data through visual interpretation and photogrammetory exercises.

Course delivery:

The course is taught through series teaching modules focussing on the course content. Practical's are taught in the laboratory with required instruments and satellite imagery focusing on each and every student so that they can get experience in the hands on application of remote sensing data through visual interpretation and photogrammetory.

Expected outcome

Students will be able to explain the fundamental concept of remote sensing, physical principles, characteristics of the images, how to process and interpret the images obtained from the remote sensing sensors. They will have the knowledge of different laboratory techniques to interpret the images and extract information by visual interpretation and by making measurements. The students will learn the multiple application of remote sensing in different fields and especially in geology.

Total Lectures + tutorials of 1 hour duration : 48
Practical classes of 2 hours duration : one class per week
Total Credits : 4 Theory – 3 Credits
Practical- 1 Credit

Suggested Books

(Remote Sensing)

- Lillesand, T.M. and Kieffer, R.W.,1987, Remote sensing and Image interpretation-Jhon wiley
- Campbell, J.B. and Wynne, R.H., 1944, Introduction to remote sensing-the Guilford press
- Pandey, S.N., 2001, Principles and applications of photogeology- New age international publishers
- Miller, V.C.,1961, Photogeology- McGraw-Hill
- Allum, J.A.E, 1978, Photogeology and Regional Mapping, Pergamon Press
- Gupta, R.P., 2003, Remote sensing geology – Springer
- Sahu, K.C., 2008, A textbook of remote sensing and geographical information system- Atlantic publishers and Distributors (p) Ltd
- Bhatta, B, 2011, Remote sensing and GIS – Oxford University Press.

Course Code: **AG3D1T & AG3D1P**

Title of the course: **Petroleum Micropalaeontology**

Course Teacher: **Prof. Kalpana Deka Kalita**

AG3D1T UNIT	Topic	No. Of lectures	
		L	**T**
UNIT I	**Micropalaeontology**: 1. Introduction to micropalaeontology, classification of microfossils, micropalaeontological techniques for extraction of microfossils. 2. Introduction to different microfossils such as foraminifera, radiolaria, ostracoda, acritarch, diatom, calcareous algae, spore & pollen, calcareous nannoplankton, dinoflagellates and their geological distribution. 3. Application of these microfossils for palaeoenvironment interpretation and petroleum exploration**.**	**03** **05** **04**	**01**
UNIT II	**Petroleum Geosciences** **1**. Introduction to petroleum geology and petroleum system 2. Source rocks and their evaluations , Rock Eval Pyrolysis, Vitrinite Reflectance, Thermal Alteration Index (TAI), Total Organic Carbon (TOC), Carbon Ratio Method 3. Kerogen, 4. Thermal maturity of microfossils and their applications in source rock assessments. 5. Colour Index (CI), Spore Colouration Index (SCI), Foraminifera Colouration Index (FCI) 6. Stable Isotope Analysis 7. Reservoir rocks and petrophysics 8. Seal rocks 9. Various trapping mechanisms for oil and gas	 **01** **03** **01** **02** **02** **03** **01** **05**	**01**
UNIT III	**Applied micropalaeontology in petroleum exploration and global climate change** 1. Biostratigraphy, Sequence Biostratigraphy and their applications in petroleum exploration and depositional environment interpretation with examples from industrial case studies. 2. To understand major global climate changes using microfossils as a proxy. 3. Introduction to biomarkers, application of biomarkers for petroleum exploration.	 **03** **03** **02**	**01**

UNIT IV	**Geology of Petroliferous Sedimentary Basins** 1. Petroliferous sedimentary basin geology 2 Classification of petroliferous sedimentary basins of India 3. Major oil and gas fields of India	 **02** **02** **02**	 **01**
Total number of lectures		**44**	**4**
UNIT V Practical AG3D1P	Microscopic identification of different microfossils and their systematic palaeontology.	**Two hours duration: one class per week**	

Total Lectures + tutorials of one hour duration : 48
Practical classes of 2hour duration : One class per week
Total Credit : 4 Theory – 3 Credits
Practical – 1 Credit

Course description: Petroleum is rock oil found primarily in sedimentary rocks. Generations of oil again happen from the organisms through various organic processes in source rocks under right temperature and pressure and then stored in the porous and permeable reservoir rocks in commercial quantities for exploitation.
Micropalaeontology deals with the study of microfossils which play an important role in petroleum exploration and in understanding major changes in global climate. Dating of the geological sequences during exploration for petroleum is supported by the microfossils data only.

Course objective: This course is designed to provide a detailed coverage of the key microfossil groups responsible for hydrocarbon generations combined with major components of petroleum geosciences. It is also to focus on the role of microfossils in understanding major changes in global climate.

Course delivery: This course is delivered through a series of taught modules focusing on the key microfossil groups and their applications in hydrocarbon exploration.

Outcome expected: At the end this course would help to get job opportunities in the hydrocarbon industries and related service sectors with knowledge of microfossils and their applications in hydrocarbon exploration and global climate change. The skills acquired by the students would provide a strong foundation for those wishing to undertake further studies towards the award of a Ph. D in micropalaeontology and hydrocarbon specialization. This course would prepare the learners for teaching professions also.

Suggested Books:

- Micropalaeontology in Petroleum Exploration: Robert Wynn Jones, Oxford Science Publication
- Applied Geological Micropalaeontology: P. K. Kathal, Scientific Publishers, India
- Applied Micropalaeontology: Ed. David Graham Jenkins, Kluwer Academic publishers
- Palaeontology – An Introduction: E. W. Nield and V. C. T. Tucker, Pergamon Press
- Sedimentation of organic particles: Alfred Traverse, Editor, Cambridge University Press
- Geology of Petroleum: A.I. Levorsen : CBS Publishers and Distributors, New Delhi
- Petroleum Geology: F.K. North, Boston Unwin Hyman Inc, USA
- Petroleum Exploration and Exploration Practices: Bhagwan Sahay, Allied Publishers Limited
- Geology for Petroleum Exploration, Drilling and Production, Norman J. Hyne 1983
- Elements of Petroleum Geology: Richard Selley, Stphen Sonnenberg Elsevier

- Sedimentology and Petroleum Geology: Knut Bjorlykke, Springer
- Petroleum Geosciences: Indian Context: Soumyajit Mukherjee, Editor- Springer
- Petroleum (Indian Context): D. Chandra and R. M. Singh, Tara Book Agency
- Petroleum Geochemistry: D. Satyanarayana, Daya Publishing House, Delhi

Course Code: **AG3D2T (DSE)**

Title of the course: **ORE PROCESSING**

Course Teacher: **Prof. M. N. Dutta**

UNIT	TOPIC	NO. OF LECTURES
I	• Concept of ore processing.	1
	• Physical Properties of Minerals.	4
	• Minerals and their classification.	1
	• Principal steps of ore processing-	
	• Communication,	3
	• Sizing,	1
	• Concentration,	2
	• Dewatering	1
II	Pre-treatment of ores-	
	• Weighing	2
	• Washing	2
	• Hand Sorting	2
	• Mechanical Sorting of ores	3
	• Mineral Liberation	1
	• Laboratory Sizing and Industrial Screening	4
III	Communication of ores-	
	• Crushing	5
	• Grinding	5
	Movements of Solids in Fluids and Classification-	1
	(a) Settling of Particles of various sizes.	2
	(b) Relationship between terminal velocity to size	2
	(c) Relationship between time & velocity of moving solids	2
	(d) Relationship between distance travel & velocity effect of Particle Shape	2
IV	Principles of the Methods of Separation of Ores-	
	• Dense media Separation(DMS)	3
	• Gravity Separation	3
	• Flotation : Concept of applicability of collectors, frothers & modifiers	3

	• Magnetic and Electrical Separation	3
	• Chemical Processing with core studies	3
	• Introduction to gemstone processing	3

Total Lectures + Tutorials of 1(one) hour duration : 64
Total Credits : 4

Course Description : Ore Processing plays an important role in geological sciences that deals with the Mineral Industries. Ore geological knowledge and its application in industries associated with separation of valuables from ores have given rise to the development of methods and techniques of ore processing. In the context of even declining grade of ores and their reserves, ore processing explains the essential steps of extraction of valuable minerals from ores.

Objective: The students of Applied Geology should have a considerable knowledge of ore processing. As such it is intended to enable the students systematically have the idea about the basic principles and methods of ore processing, its application in industries and to make themselves receptive to modern techniques of ore processing.

Course Delivery: The course shall be taught with a series of teaching methods/ modules that are easily acceptable by the students, focusing on the course content.

Outcome Expected: The course is designed as to how the valuable parts can be extracted from an ore in practice and to make the students understand about how an ore being processed. it is also expected that the students can acquire the skills for extraction of valuables from an ore.

Suggested Books:

- **Gaudin, A. M.**, principles of Mineral Dressing, McGraw Hill Book Company Inc., 1971.
- **Jain, S. k.**, Ore Processing, Oxford and IBH Publishing Co. Pvt. Ltd., 1986.
- **Pryor, E. J.**, Mineral Processing Applied Science Publishers Ltd., London, 1974.
- **Gokhale, K. V.G. K. and Rao, T. C.,** Ore Deposits of India, Thomson Press (India) Ltd., 1978

Course No. : **AG3D3T , AG3D3P**
Title of the Course : **Fluvial Geomorphology**
Name of the Course Teacher : **Dr. Ratamali Machahary**

Unit	Topic	No. of Lecturers
I	Meaning, scope and evolution of fluvial geomorphology	3
	Fluvial system, Fluvial regime	6
	Modern methods and techniques in fluvial geomorphological studies: Remote sensing, GIS and computer applications.	3
	Drainage basin as a fluvial system: inputs and outputs in the basin, drainage basin as a fundamental geomorphic unit.	4
	Channel process: forces acting in channel, flow types, velocity distribution, water and sediment discharge, channel erosion and deposition.	4
II	Channel patterns: Straight, meandering, anabranching and braided. Geometry of meanders, development and causes of meandering, mechanics and causes of braiding.	3
	River channel changes, channel metamorphosis, misfit stream.	3
	Flood geomorphology: flood as geomorphic agent, flood frequency analysis, recurrence interval. Paleoflood analysis.	4
	Floodplain morphology of Brahmaputra river and its tributaries	4
	Fluvial geomorphology of the Brahmaputra Valley.	3
	Channel Morphology of the Brahmaputra river	5
III	Active tectonics and alluvial rivers.	6
IV (Practicals) AG3D3P	Preparation of hydrographs, rating curves, flow duration curve	2
	Water discharge and sediment load analysis	3
	Flood frequency analysis using (i) Plotting position (ii) Log pearson Type III distribution and (iii) Gumble's method.	4
	Determination of recurrence interval.	2
	Identification of different geomorphic units form satellite imagery	1
	Morphometric and Morphotectonic Analysis	4

Total Lectures + tutorials of 1 hour duration : **48**
Practical classes of 2 hours duration : **one class per week**

Total Credits **: 4 Theory – 3 Credits**
Practical- 1 Credit

Description:-
Fluvial geomorphology is developing rapidly with the expansion of modern technology in present time. Fluvial geomorphology is a science devoted to understanding rivers, both in their natural setting as well as how they respond to human induced changes in a watershed. The course deals with the basic concept, scope, and evolution of the fluvial geomorphology, different fluvial processes, channel pattern, their changes and adjustment, and fluvial landscape development along with the modern techniques use in the fluvial geomorphological studies.

Objective:-
The main objective of this course is to give the basic concept of the fluvial geomorphology, its scope, and importance. It provides an explanation of relationships among the physical properties of flow in mobile bed channels, the mechanics of sediment transport driven by the flow and the alluvial channel forms created by spatially differentiated sediment transport. The study of the form and function of streams and the interaction between streams and the landscape around them.

Course delivery: -
The course is taught through a series of teaching modules focusing on the course content. Practicals are taught focusing on each and every student so that they can get knowledge on preparation of hydrographs, flood frequency analysis and morphometric techniques of landform analysis

Expected outcome:-
At the end of the semester the students will have the understanding of the fluvial system, different fluvial processes, the relationship between channel form and processes, channel pattern and adjustments and different modern techniques used in geomorphological studies.

Suggested Books

- Charlton, R., 2007, Fundamentals of Fluvial Geomorphology.
- Schumm, S.A., 2005, River variability and complexity, Cambridge University
- Grade, R.J., 2006, River Morphology, New Age International (P) Limited Publishers
- Singh, V., Sharma, N., Ojha, C.S, 2004, The Brahmaputra Basin water resources, Springer Netherlands
- Burbank, D.W. and Anderson, R.S., 2008, Tectonic Geomorphology – Blackwell science
- Goudie, A., 1990, Geomorphological Techniques, Routledge Taylore & Fancis Group

Course No. **: AG3D4T**

Title of the Course **: Isotope Geochemistry**

Name of Course Teacher **: Prof. P. Bhattacharyya**

Unit	Topic	No. of Lecturers
I	1. The origin of isotope geology.	2
	2. Isotopes and their impacts in geology, cosmic abundance of elements and characteristics.	4
	3. Stable isotopes and their fractionation.	4
	4. Radioactive decay and growth. i. Decay of radioactive parent to a stable daughter. ii. Decay series. iii. Nuclear fission. iv. Units of radioactivity and dosage. v. Neutron activation.	5
	5. Mass spectrometry, Type, Isotope dilution analysis.	6
II	6. Principles and procedures of the following radioactive dating methods.	
	i. K-Ar dating	4
	ii. Rb -Sr dating.	4
	iii. Sm-Nd dating	4
	iv. U-Pb dating.	4
	v. Fission Track dating.	5
III	7. Isotope geology of Ar, Sr & Nd	4
	7. Oxygen and Hydrogen isotopes and their application	6
	8. Isotope geochemistry related to petrology	6
	9. Evolution of isotopic reservoirs in mantle and crust.	6

Total Lectures of 1 hour duration : 64
Total Credits : 4

Course description:- Isotope geochemistry deals with studies of characteristics of both radio and stable isotopes, their ratios. The course is essentially framed to understand geochronology and geochemistry of the earth's crust and mantle, meteorities-their compositions, relation to earth. Isotope Geochemistry is found to be more useful to understand the Petrogenesis of igneous and metamorphic rocks.

Objective: The course is designed to familiarized the students with isotopes, isotopic ratio, isotopic dating in rocks and minerals.

Course delivery:-The course will be delivered with different teaching modules. The course will be deliverers through hands-on training in laboratory supported by theory classes.

Outcome expected:- At the end, students will learn the basics of isotope geochemistry. Its importance in understanding the earth, its geochemical differentiation ,age and dates of rocks and minerals,exhumation rates, thermal history of a basin. Further, students will be made ready for Research works as well as preparing themselves for various competitive examinations.

Course No. **: AG3G1**

Title of the Course **: Water Science, Policy and Governance**

Name of the Course Teachers **: Dr. S.K. Lahiri**

Unit	Topic	No. of Lectures
I.	The water crisis; Importance of studying water; Current global water balance; Water as the prime driver of socio-economic growth; Trans-boundary conflicts within states of India; River basin politics; Integrated Water Resources Management (IWRM) at different levels; International Organizations and Water Policy debates; Distribution and Classification of Aquatic Ecosystems; Drivers of Change in Inland Aquatic Ecosystems.	
II.	Global hydrology; The Earth System and Water; Water Reserves, Fluxes and Residence Time; Global water cycle; Global water-balance requirements; Precipitation, observation and measurement; Precipitation modelling; Precipitation and engineering design; Trends and variability in Global Evaporation; Interception; Infiltration; Observation of Hydrological Processes using Remote Sensing; Hydrogeophysics, Geophysical methods, Case Studies; Hydrological modelling; Uncertainty of Hydrological Predictions; Water Chemistry; Water biology; Quality of drinking water analysis.	
III.	The Hydrodynamics and morphodynamics of Rivers, Lakes and Reservoirs; Hydrology and ecology of river systems; Flood and bank erosion; sediment budgeting; Artificial Embankments and River bed-river bank dynamics; Incubation and triggering of flood disasters; Flood Disaster Risk Reduction.	
IV.	Origin and age of groundwater; rock properties affecting groundwater; geologic formations as aquifers; Types of aquifers; Groundwater movement; Darcy' Law; Permeability; flow rates; flow directions; Groundwater levels and environmental influences; Quality of ground water; Pollutants of Ground Water of Assam and their social impact on health and remedial measures; Surface and subsurface geophysical investigations of groundwater; Artificial recharge of groundwater; Saline water intrusion in Aquifers.	
V.	Water as an Economic commodity - Old and new concepts; Water Supply and Demand; International and National Water Policies; Managing surface water; Managing Ground water; Water in the Industry; Water availability and its use in agriculture; Ramsar Convention on Wetlands; Groundwater sustainability and future management issues; Types of governance for river basin management; Basin governance challenges; Reconceptualizing water governance, Uses of Inland Waterways.	4

Total Lectures of 1 hour duration **: 64**
Total Credits **: 4**

Course Description: This course is essentially supposed to be studied in five components. Some of the major issues, traditional as well as newly developing in the local as well as global perspective will be taken up in the first unit. The second unit will be devoted to address the connectivity of water with different branches of science. The third unit will deal with surface water which is supposed to cover flood and erosion issues and then taking up measures for flood disaster risk reduction. Fourth unit will be devoted to ground water which besides discussing aquifers will also take up problems related to ground water level depletion, ground water pollution and salt water intrusion etc. The last unit will deal with the linkage of water with society - national and international policies on water and the modalities suggesting sustainable, inclusive and effective water governance.

Objectives: Water was considered an elixir of life since time immemorial but in the last one hundred years the understanding of water has become so diverse and the reach of its scope so pervasive that for any sensible person systematic study has become a must. This course is supposed to open up a multi-disciplinary understanding of water. For inquisitive candidates coming from either science or humanities background, it is going to help to take up higher studies with confidence.

Course delivery: The course content will be delivered mostly in the form of lectures and interactive discussion sessions. Experts will be invited as and when required from the academicians, scientists, researchers, technocrats and administrators. Besides the time tested traditional methods of 'Chalk-talk', power point presentations, sharing of experiences in the form of lively discussions will be encouraged. Emphasis will be given to drive the point that every participant can choose a problem-solving approach to do some activism and deliver something substantial to promote cultural content of the civil society

Outcome expected: After completion of the course, a candidate will be in a position to realize sharp changes on the following aspects:

1. Appreciation of water as a multi-disciplinary subject
2. An ability to connect international relations and explain regional conflicts with better clarity
3. Greater awareness towards the environmental degradation and maintenance of water quality
4. Playing leadership role to check pollution; joint initiatives in mitigating or reducing big disasters like floods and erosion by timely intervention to save precious lives and property.

Suggested books

- Aswathanarayana, U., 2005. Advances in Water Science Methodologies, Taylor and Francis.
- Fetter, C.W., Applied Hydrogeology, 4th Edition, Prentice-Hall.
- Spellman, Frank R., 2008. The Science of Water: Concepts and Applications, 2nd Edition, Taylor & Francis Group.
- Todd, David Keith. and Mays, Larry W. 2005. Groundwater Hydrology, 3rd Edition, John Wiley & Sons.
- Wilderer, Peter (Editor-In-Chief), 2011. Treatise on Water Science, 4 Volumes, Elsevier.

Course No. : **AG3G3T**

Title of the Course : **Geoscientific Data Analysis with Matlab and Petrel**

Name of the Course Teacher : **Dr. Geetartha Dutta**

Unit	Topic	**No. of Lectures**
I.	Introduction to Matlab: Common functions and operations; Arrays: vectors and matrices; Array indexing: subscript indexing, linear indexing and logical indexing; Visualizing data: line plots, scatter plots, polar plots, rose plots, compass plots, contour plots, surface plots, histograms and images; Matrix operations and manipulations; Vectorization; Scripts and Functions.	10
II.	Image processing using Matlab: Transforms: Fourier transform, discrete cosine transform, radon transform, wavelet transform; Filters: Gaussian filter, Laplacian filter, moving average filter, median filter; Frequency responses; Speckle noise removal; Image reconstruction; Edge detection; Image thresholding; Properties of image regions.	10
III.	Signal processing using Matlab:Fast Fourier transform; Sampling and aliasing; Spectral analysis; Power spectral density; Cross correlation and auto correlation; Time-frequency spectrogram; High-pass and low-pass filters; Downsampling and removing trends in data; Principal component analysis.	10
IV.	Simulation, regression, classification and optimization:2D random walk; Monte Carlo simulation; Bootstrapping; Kernel density estimate; Probability density functions; Empirical cumulative distribution; Linear least squares regression; Eigenvectors and eigenvalues; Polynomial fitting; Non-linear least squares regression; Classification: Logistic regression, Classification trees, Neural networks, Support vector machines; Optimization; Objective functions; Numerical solution of ODEs; Numerical integration and discretization.	24
V.	Reservoir modeling using Petrel:Petrel basics; Preparing data; Making surfaces and grids; Geological modeling; Visualization.	10

Total Lectures of 1 hour duration : **64**
Total Credits : **4**

Description:- Matlab is a high-level programming language and interactive environment for mathematical computation, analysis, visualization and algorithm development. Matlab is widely used in various disciplines of science and engineering which require numerical analysis, matrix computation, signal processing, image processing, simulation, regression and optimization. These applications are ubiquitous in geoscientific data analysis, and hence Matlab has extensive use in geosciences. Petrel is an Exploration & Production (E&P) software platform which integrates multiple disciplines for making better decisions.

Objective: The course is designed to provide students the basics of Matlab and Petrel, along with knowledge and practice of implementing various techniques and algorithms which are useful in geoscientific data analysis.

Course delivery: The course is delivered through a series of class lectures and hands-on exercises using Matlab and Petrel.

Outcome expected: Students, after completing this course, are expected to be well prepared to implement various techniques and algorithms in Matlab and Petrel. The knowledge and skills acquired in this course will help students in their future research, if they pursue a Ph.D. Some of the course materials, especially those involving Petrel, will also be useful in pursuing a career in the industry.

Suggested Books

- Menke, W. and Menke, J. (2016). *Environmental Data Analysis with Matlab*. Academic Press.
- Hanselman, D. and Littlefield, B. (2011). *Mastering Matlab*. Prentice Hall.
- Moler, C. (2004). *Numerical Computing with Matlab*. SIAM.
- Van Loan, C.F.and Fan, K.Y.D. (2010). *Insight Through Computing: A MatlabIntroduction to Computational Science &Engineering*. SIAM.
- Middleton, G.V. (2000). *Data Analysis in the Earth Sciences using Matlab*. Prentice-Hall.
- Johnson, R.K. (2011). *The Elements of Matlab Style*. Cambridge University Press.
- Online resources at https://www.software.slb.com/products/petrel

Course No. **: AG3A1T**

Title of the Course **: Elements of GIS**

Name of Course Teacher **: Dr.(Mrs) Ratamali Machahary**

Unit	Topic	No. of Lectures
I.	Introduction and definitions of GIS , components, application areas of GIS, advantages and disadvantages of GIS	3
	Data formats, Data structure, Raster data model and vector data model, Raster versus vector, Advantages and disadvantages of raster and vector	3
	Functional elements of GIS: Data acquisition, Data input and data processing, data management system, product and report generation	2
	Concept of database and DBMS	3
II.	Coordinate systems: Cartesian Coordinate System, Geographic Coordinate system	3
	Map Projection: Definition, Classification and types map projection, Polyconic projection, UTM projection, Latitude/Longitude geographic coordinates	4
	Digital Image processing and GIS softwares (ArcGIS, ERDAS)	3
III.	Geometric Registration: Georeferencing of toposheet of the area, satellite image with a toposheet, image to image referencing, Re-projection, Creating FCC image from raw data (layer stacking/band combination), Image clip, masacking	4
	Working with ArcGIS software: Creating vector files, digitization, attribute generation, labeling, symbolizing and preparation of map	5
	DEM analysis: contours extraction, slope map, aspect map	2

Total classes of 1 hour duration : 32
Total Credits after calculation : 02

Description:
GIS (Geographic Information System) is a computer assisted information management system of geographically referenced data. A GIS differ from conventional computer assisted mapping and attribute data analysis system. GIS provides an exceptional means for integrating timely remote sensing data with other spatial and thematic data types.

Objective:
The course is designed to provide a basic knowledge of GIS, concepts, terminology, methods of Geographic Information System technology, practical understanding, techniques and real world applications of GIS.

Course delivery:
The course is taught through a series of teaching modules focussing on the course content. Practical's are taught in computer laboratory focusing on each and every student so that they get hold on image processing, image interpretation, DEM analysis and working with different GIS software's.

Expected outcome
At the end of the semester, the student will have basic knowledge of GIS, technical languages of GIS, practical understating of the GIS concept. They will have hands on knowledge on image processing,

image interpretation, image classification, DEM analysis, have hold on working with GIS software and map preparation.

Suggested books

- Sahu, K.C., 2008, A textbook of remote sensing and geographical information system- Atlantic publishers and Distributors (p) Ltd
- Bhatta, B, 2011, Remote sensing and GIS – Oxford University press
- Demers, M.N,1997, Fundamentals of Geographic Information systems, John Willey &sons.Inc.

4th Semester

Course No. : **AG401T, AG401P**

Title of the Course : **Geophysical Exploration**

Name of Course Teacher : **Dr. S.K. Lahiri and Dr. Geetartha Dutta**

Unit	Topic	No. of Lectures
I.	1. Scope of the subject in relation to hydrocarbon, mineral and ground water exploration.	2
	2. Geophysical properties of rocks and minerals.	2
	3. Field theory: Newtonian potential; Laplace and Poisson's equations; Green's Theorem; Gauss's law; Continuation integral; equivalent stratum; Maxwell"s equations and electromagnetic theory; Displacement potential, Helmhotz's theorem and seismic wave propagation.	5
	4. Elements of inversion: What is inversion theory? What are the goals of inverse analysis? Examples of forward problems like fitting a straight line, a parabola; tomography; convolution etc. Matrices and Linear Transformations, Probability and Statistics	5
	5. Electrical methods of surveying. 5.1. Surveying natural potentials : Exploring shallow natural potentials, Telluric currents, Telluric current surveying, Magneto telluric surveying, Field examples. 5.2. Electromagnetic surveying : The principle of EM surveying, parallel line dip angle EM surveying, Horizontal-loop EM surveying, Airborne EM surveying, Field examples. 5.3.Induced polarization surveying : Source of induced potential, Measuring induced potentials, Results of IP surveying, Field examples. 5.4. Electrical resistivity surveying : Ohm's law and resistivity, current flow in three dimensions, current density, current flow across a boundary, Measuring resistivity, Equipment for electrical resistivity surveying, Sounding and profiling, Forward and Inverse methods of resistivity data interpretation. The methods of characteristic curves and use of computer softwares, Resistivity profiles over faults and dykes, Resistivity and lithology.	3 3 2 5
II.	**6. Numerical analysis and inversion:**	5

	Numerical differentiation and integration, finite element, and finite difference techniques; Simpson's rules; Gauss's quadrature formula; initial value problems; pattern recognition in Geophysics. Well posed and ill-posed problems; method of least squares; direct search and gradient methods; generalized inversion techniques; singular value decomposition; global optimization.	
III.	**7. Gravity and Magnetic methods** : General principles, General principles behind the instrumentation, zero length spring and Warden gravimeter, Proton precession magnetometer, Field procedures, Corrections, General discussion on interpretation, case histories.	6
IV.	**8. Reflection and Refraction methods :** Different types of seismic waves, Acoustic impedance, Reflection & Refraction coefficients, Signal and Noise, Raypath seismology for two layered earth-horizontal and dipping. Geophones, General discussion on data acquisition, processing and interpretation, VSP.	6
V.	**9. Different types of logging techniques** : Application of the geophysical logging techniques in Ground Water, Minerals and Hydrocarbons. 2D/3D surveying and its application. Reservoir properties & Petrophysics of rocks, Basic concept of Log interpretation, General familiarity with different types of logging tools and their responses.	4
VI. **(Practicals)** AG401(P)	1. Interpretation of self-potential survey data by drawing profiles and contouring the data.	Two hours duration: one class per week
	2. D.C. electrical resistivity sounding for groundwater prospecting using different types of arrays such as Schlumberger, Wenner etc. and interpretation of the data.	
	3. D.C. electrical resistivity profiling using dipole-dipole configuration and interpretation of the subsurface by drawing pseudo cross-section for shallow subsurface geological problems (mineral exploration, neotectonics etc.)	
	4. Different types of field data corrections and interpretational techniques adopted for gravity and magnetic data (for studying the basement, mineral exploration and basin analysis)	
	5. Interpretation of seismic refraction data to find out the depth to bedrock in a dam site survey. Engineering refraction problem for the multi-layered earth to find out the depth of different layers, their respective thickness and nature of dip (direction and magnitude).	
	6. Uphole survey data interpretation for the determination of weathering layer (Low velocity layer) thickness as well as computation of weathering and sub- weathering	

	layer velocities.	
	7. Interpretation of seismograms for reflection data using DIX method to find out actual velocities for different layers, using RMS velocities and calculation of the respective thickness.	
	8. Identification of unconformities, faults and different types of structural and stratigraphic elements in the seismic sections.	
	9. Basics of openhole wireline geophysical log interpretation techniques-qualitative and quantitative.	
	10. Elements of sequence stratigraphy by using geophysical logs and well processed seismic sections and their correlation with the outcrop based stodies	

Total Lectures + tutorials of 1 hour duration : 48
Practical classes of 2 hours duration : one class per week
Total Credits : 4 Theory – 3 Credits
Practical- 1 Credit

Course description: The course structure is essentially divided into three units. First unit introduces scope of geophysical methods basically in the oil, minerals and ground water exploration. This unit also introduces essential physics, numerical analysis and inversion theory. Second unit covers different geophysical tools like, electrical, electromagnetic, Gravity-Magnetic and seismic. A quick look towards well logging is also included in this segment. Third unit is related to some practical exercises.

Objectives: This course is supposed to meet the following objectives:
1. Introduce the importance of handling geophysical tools to the students having geology background and thereby relate outcrop studies with the subsurface extension of cause and effect relationships
2. To develop problem solving attitude among the geology students by incorporating geophysical data sets in their future research activities.
3. Boosting the employability of the geology students in the industries related to earth resources exploration and exploitation.

Course delivery: Geophysical concepts will be delivered in the form of lectures, problem solving sessions by using black board, power point presentations in relation to different geological situations.

Outcome expected: After attending the course, the candidates are supposed to
1. feel confident in facing different national and international level entrance examinations particularly meant for the geo-science students either for getting employment in the industries or for joining research activities at higher level.
2. master a deterministic approach while facing probabilistic situations which help to appreciate earth system science in a concrete manner.
3. understand the real essence of participating in the process of nation building to improve the quality of life and make the earth a better place to live in a harmonious way with fellow human beings and other living species.

Suggested books:

- Blakely, Richard J., Potential theory in gravity and magnetic applications, 1st Published, Cambridge University Press, 1995.
- Dobrin, M.B., Savit, C.H. Introduction to Geophysical Prospecting, 4th Ed. McGraw Hill, 1988.

- Dewan, J. T., Essentials of Modern Open-hole Log Interpretation, PennWell Books, 1983.
- Lowrie, W., Fundamentals of Geophysics, 2nd edition, Cambridge University Press, 2007.
- Menke, W. *Geophysical Data Analysis: Discrete Inverse Theory*. Academic Press, 2018.
- Mussett, A. E., Khan, M.A., Looking into the earth: An introduction to geological geophysics, 1st Published, Cambridge University Press, 2000.
- Robinson, E.S., Coruh, C., Basic Exploration Geophysics, 1st ed., Wiley, 1988.
- Roy, K.K., Potential Theory in Applied geophysics, Springer, 2008.
- Sastry, S. S., Introductory methods of numerical analysis, Prentice-Hall, New Delhi, 1983.
- Scales, J.A., Smith, M.L. and Treitel, S. (2001). *Introductory Geophysical Inverse Theory*. Samizdat Press.
- Sheriff, R.E., Encyclopedic Dictionary of Applied Geophysics, Fourth edition ,Society of Exploration Geophysics, 2001.
- Sheriff, R.E., & Geldart, L.P., Exploration Seismology Vol. 1 & 2, Reprint ed. Cambridge, 1986, 1987.
- Tarantola, A. *Inverse Problem Theory and Methods for Model Parameter Estimation*. SIAM, 2005.
- Telford, M., Geldart, L.P., Sheriff, R.E. and Keys, D.A., Applied Geophysics, 1st Indian ed. Oxford & IBH, 1988.
- Yilmaz öz, Seismic Data Analysis: Processing, Inversion and Interpretation of Seismic Data, Society of Exploration Geophysics, 2000.

Course No. : **AG402T, AG402P**

Title of the Course : **Petroleum Geology**

Name of the teacher and Course : **Prof. Kalpana Deka Kalita and Dr. D. Bhuyan**

Unit	Topic	No. of Lectures	Name of the Teacher
I.	**Principles of Petroleum Geology.**		**Prof. Kalpana Deka Kalita**
	1. Introduction to Petroleum Geology	2	
	2. Mode of occurrences of petroleum: Surface, subsurface and Miscellaneous	4	
	3. Physical and chemical nature of petroleum.	2	
	4. Organic/Inorganic Origin of petroleum Migration and accumulation of Petroleum.	3	
	5. Source rocks, Source Rock Evaluation, Rock Eval pyrolysis	5	
	6. Conversion of organic matter into Petroleum	3	
	7. Reservoir fluids : Gas, Oil and Water	3	
	8. Clastic and non-clastic reservoir rocks	6	
	9. Trapping Mechanism for Oil & Gas: Structural, Stratigraphic and Combination traps.	6	
	10. Concept of petroleum bearing basins and basin geology.	3	
	11. Petroliferous basins of India	1	
II.	**Petroleum Geology of India and world**		**Dr. Diganta Bhuyan**
	12. Geology of major oil and gas fields of India.	3	
	13. Future trends of oil exploration.	1	
	14. Details study of oil-gas fields of NE region.	2	
	15. World oil and gas reserves. A brief review of the important oil fields of the world.	3	
III. Practical AG402P	Source rock characterization	**Two hours duration: one class per week**	
	Iso-pach map preparation		
	Identification of traps in the subsurface		

Total Lectures + tutorials of 1 hour duration : **48**
Practical classes of 2 hours duration : **one class per week**
Total Credits : **4** **Theory – 3 Credits**, **Practical- 1 Credit**

Course Description :- Petroleum Geology plays an important role in geological sciences, providing the detailed knowledge of occurrence, origin, source, reservoir, trap, petroliferous basins and important oil and gas fields of India as well as India and specially NE India.

Objective: The course is designed to provide the students a detailed coverage of the topics related to petroleum and petroleum exploration.

Course delivery: The course is delivered through a series of taught modules focusing on the principles of petroleum geology and their applications in hydrocarbon exploration.

Outcome expected: The course is mainly designed to prepare students for work in the hydrocarbon sector with a knowledge of petroleum geology in details. The skills acquired by the students will also

provide a strong foundation for those wishing to undertake further postgraduate study towards the award of a Ph D in petroleum geology. The students will be prepared for teaching professions also.

Suggested books:

- Geology of Petroleum: A.I. Levorsen : CBS Publishers and Distributors, New Delhi,1985
- Petroleum Geology: F.K. North, Unwin Hyman Inc, Boston, USA
- Petroleum Exploration and Exploration Practices: Bhagwan Sahay, Allied Publishers Limited, 1994
- Geology for Petroleum Exploration, Drilling and Production, Norman J. Hyne, 1983
- Elements of Petroleum Geology: Richard Selley, Stphen Sonnenberg Elsevier
- Sedimentology and Petroleum Geology: Knut Bjorlykke, Springer, 1989
- Petroleum Geosciences: Indian Context: Soumyajit Mukherjee, Editor- Springer, 2015
- Petroleum (Indian Context): D. Chandra and R. M. Singh, Tara Book Agency, 2003
- Petroleum Geochemistry: D. Satyanarayana, Daya Publishing House, New Delhi, 2011
- Sedimentation of Organic Particles: Alfred Traverse, Cambridge University Press 1994
- Oil and Gas Fields of India: Lakshman Singh, Indian Petroleum Publisher

Course No. : **AG403T, AG403P**

Title of the Course : **Exploration and Development of Hydrocarbon Fields**

Name of the teacher and course : **Prof. D. Majumdar, Prof. U. Goswami and Ms. Pallabi Borkakoty**

Unit	Topic	No. of Lecturers	Name of the Teacher
I.	1. Petroleum Exploration: Sequences of operations undertaken in petroleum exploration- geological, geochemical and geophysical methods : Exploratory drilling of wells. Preparation of structural, paleostructural, isopach, facies and hydrocarbon prospect maps. Exploration strategies for different types of traps – structural, stratigraphic, lithological and combination.	10	Ms. Pallabi Borkakoty
	2. Oil well drilling and techniques, Coring and Mud logging, casing and cementing (GTO)	10	Prof. U Goswami
	3. Well site geology: duties of well site geologist, geotechnical order.	4	
II.	4. Exploitation and Development of oil and gas fields: exploration of Single zone and Multizones, primary, secondary, and enhanced oil recovery, Preliminary ideas of reservoir dynamics.	8	Prof. Dilip Majumdar
	5. Formation testing and interpretation of testing data.	8	
	6. General principles of development, well spacing and drilling priority, development strategy under different reservoir conditions.	5	
	7. Oil and gas reserves-their classes and estimation.	3	
III. **Practical AG403(P)**	1. Preparation of structural and isopach maps from well data.	Two hours duration: one class per week	Prof. Dilip Majumdar
	2. Quantitative determinationof porosity, permeability, oil saturation, water saturation and formation factor with the help of geophysical well logs.		
	3. Calculation of oil and gas reserves.		
	4. Graphical presentation of production data.		
	5. Interpretation of BHP data.		

Total Lectures + tutorials of 1 hour duration : **48**

Practical classes of 2 hours duration : **one class per week**

Total Credits : **4** (**Theory – 3 Credits**, **Practical- 1 Credit**)

Course description: The course is a selection of topics on petroleum geology, prospecting requirements and engineering skills needed for the planning, development and operation of oil and gas fields. Topics typically covers the basics of life cycle of a hydrocarbon field, studies on formation evaluation, field development workflow, reserve estimation, project economic evaluation, offshore field architectures and production systems, reservoir depletion and field performance, data acquisition procedure and data management in the oil and gas industry

Objectives: The students should understand the petrophysical parameters of the reservoirs, formation evaluation practices and data acquisition, reserve estimation and aspects of petroleum engineering in formulating the development plan and operating oil and gas fields.

Course delivery: Lectures, exercises and industrial training will be the essential components of course delivery. The exercises on actual case studies will be the important part of practical paper and weeklong industrial training is made compulsory depending upon the facilities available.

Outcome Expected :At the end of the term, students should understand the process of planning and developing on and offshore oil and gas fields and certain important petroleum engineering aspects that govern the operation of such fields. Students should be able to describe the lifecycle of oil and gas fields from discovery through the assessment phase, the development phase, field operations and abandonment. Students should also understand the risks, uncertainties and economic factors involved in the development and operation of oil and gas fields.

Suggested Books:

- Encyclopedia of Well Logging, Robert Desbrandes, Institutfrancais du petrole Publications, 1985.
- Reservoir Engineering Handbook, Tarek Ahmed, Gulf Professional Publishing, 2010.
- The Geological Interpretation of Well Logs, Malcolm Rider, Gulf Pub Co, 1996.
- Production Operations: Well Completions, Workover and Stimulation, Vol 1, Thomas O Allen and Alan P. Roberts, Oil and Gas Consultants International, 1982.
- Fundamentals of Reservoir Engineering, L P Dake, 1978.
- Fundamentals of Well Log Interpretation, Vol 1, Vol 2, O. Serra, Elsevier Science Publisher, 1984.