INSTITUTE OF HYDROCARBON, ENERGY AND GEORESOURCES

Programme: M.Sc. in Applied Geology (with specialization in Petroleum Geosciences) **Credit:** 96 **Semester:** 4

The syllabus for M.Sc. in Applied Geology (with specialization in Petroleum Geosciences), will be applicable for students enrolled w.e.f. July 2020 and onwards.

Program Outcome:

The M.Sc. in Applied Geology (with specialization in Petroleum Geosciences) program at the Institute of Hydrocarbon, Energy and Geo-Resources, ONGC Centre of Advanced Studies, University of Lucknow, is designed with the objective of enhancing the practical and theoretical knowledge base of the students, leading to their over-all skill development. The students are tuned to face the present day challenges and opportunities of employability. The problem solving attitude, better oral and written communication skills infused in the students over the two years, helps in educating students for success as a geo-scientist in government sector, public sector, private sector, research institutes etc. This enhances their potential for finding better placements in the present challenging scenario. It is also endeavoured to improve the Infrastructure with the state of art technological developments so that the students are also tuned to emerging developments in the proper and optimum resource management. The overall knowledge of students helps them in qualifying the NET or Gate Examinations so as to pursue the career in academics or other competitive examinations. With these holistic developments, the students are likely to get regular placements in multinational Oil & Gas Industries, ONGC, GSI, Mining Industries etc. apart from other Indian Industries related to oil and gas exploration, mineral exploration and mining etc.

Programme Specific Outcome:

During the proposed first and second semester, students identify, examine and understand different geological materials and geological settings. The students learn to interpret various geological maps, prepare cross sections, geologic field mapping, basic understanding of geological materials, rock identification on the basis of minerals composition and basic physical megascopic and microscopic characters and association, origin and evolution of landforms, fossils identification, in-depth understanding of the sedimentary structures and facies analysis, paleoclimatic and palaeogeographic changes, origin and distribution of economic resources of the country etc.

The students in their third semester onwards, are tuned to the specialized domain of petroleum geo-sciences. The syllabus incorporates detailed knowledge about the different sedimentary basins in

India, the Indian Petroliferous basins, as also the geophysical and seismic techniques. Specialized courses on Sequence Stratigraphy, Exploration, Drilling, Production and Reservoir Engineering and Well Logging techniques. Further students are taught to work out the Techno-Economics and learn more about the different types of Energy Resources and Geochemistry. Exploration for economically useful Earth materials is another important outcome of the present program.

In order to enhance the knowledge base and confidence level amongst the students, during each of the semesters, the students are encouraged to prepare detailed Assignment Reports on separate topics given to each of them. They are also made to make a power-point presentation before all other students and the faculty members. This enhances their written and oral communication skills which are so important in their future professional carriers. The students are further provided with a Dissertation topic in their second and fourth semesters, so as to enhance their written and oral communication expertise.

Geological excursion and research based activities are important component of Master's Program in Applied Geology. As such, the syllabus is so formulated, so as to expose the students to the geological field work during the second and the fourth semester. The students are exposed to different types of geological and rock formations, from Himalayas to Rajasthan, to the mining areas in different parts of the country. Identification of geological formations, their structural, sedimentological studies as also the Geological mapping is essential part of geological excursions. Additionally, the students are made to visit different laboratories of national and international fame, so as to get acquainted with newer techniques of geological studies.

M. Sc. Programme in Applied Geology (Four Semesters)
(With Specialization in Petroleum Geosciences)

Syllabus for the M.Sc. Programme in Applied Geology, (With Specialization in Petroleum Geosciences), Institute of Hydrocarbon, Energy and Geo-Resources, ONGC Centre of Advanced Studies,

- **This syllabus shall be applicable for students enrolled in academic session 2020-21 and onwards ie. w. e. f. the Examination of December 2020.**
- **For students enrolled in the year academic session 2019-20 and earlier, the syllabus and pattern of examination shall be the same as already in practice**

Eligibility of candidates for admission to M.Sc. Programme in Applied Geology:

Candidates who have passed the three year B.Sc. examination of the University of Lucknow or any other equivalent examination of other universities (considered as equivalent by the University of Lucknow) (i) with Geology as one of the main subjects at graduate level with minimum percentage of marks (or equivalent CGPA) as 45% for General/OBC and 40% for SC/ST or (ii) without Geology as one of the main subjects at graduate level with any two of the following

subjects: (a) Chemistry, (b) Physics, (c) Mathematics and (d) Life Sciences (Zoology and/ or Botany), (e) B.Tech./ B.E. with percentage of marks (or equivalent CGPA) as 50% for General/OBC and 45% for SC/ST, will be considered eligible for the admission.

This is a **Self-Financing Course** with an intake of 25 seats per annum.

The fee structure will be INR 30,000 per Semester.

Admission to the Four Semester M.Sc. Programme in Applied Geology (with specialization in Petroleum Geosciences), for the eligible candidates, will be as per Lucknow University rules. In case of Entrance Test, the Test Paper, will be in English only and will be of U.G. level of the University of Lucknow in Geology, mainly Physical Geology, Physiography of India, Natural Hazards, Economic Geology, Remote Sensing and Environmental Geology etc.

Syllabus and Evaluation for M.Sc. Programme in Applied Geology:

The M.Sc. Programme in Applied Geology shall be of two academic sessions consisting of four semesters. Candidates will be examined through Continuous Internal Assessment and evaluated at the end of each semesters in the different courses of Theory, Practical, Field Work and Project work, as per the details and marks given against each course. The papers will be set in English, and the students will be required to answer the questions in English only.

Evaluation in Semesters:

For the Continuous Internal Assessment of the candidates, 30 marks shall be awarded by the teacher(s), teaching that Paper, for which the breakup of the marks will be as follows:

Class Test(s) /Assignment(s)/ Presentation(s)/ Class Participation **30 marks**

For the Semester End Examinations, the question papers for each course will be of **70 marks**

Programme Structure:

Core Course: Course which is compulsory to all students pursuing M.Sc. in Applied Geology.

Freezed Elective: Student pursuing M.Sc. in Applied Geology would have the choice to opt a paper of her/his interest from the proposed list of Freezed electives.

Inter Departmental Open Elective Course: A course which is open for any Master's student, belonging to any Department of the Science Faculty of the University, There is capping of 30 students.

MOOCs (Massive Open Online Courses**): Any student will have the freedom to choose similar course of 4 credits** out of the MOOCs portal of UGC. In place of the Inter-departmental open elective course, MOOC courses may be opted depending upon the availability on Swayam portal. Necessary Registration fee etc. would be the responsibility of the student who would inform the HOD and the COE before the beginning of the semester. The student will be responsible for applying, making required payment as well as submitting of the grades to the University.

M.Sc. Applied Geology Syllabus based on CBCS

Semester I

Course	Papers	Type	Credit	Actual teaching No. of Hours
Core Course	PAPER 1	Theory	4	48
	PAPER 2	Theory	4	48
	PAPER 3	Theory	4	48
	PAPER 4	Theory	4	48
Practical Laboratory Work & Viva-voce	PAPER 5	Practical	4	96
Project Work	PAPER 6	Theory	4	96
		Total	24	

Semester II

Course	Papers	Type	Credit	No. of Hours
Core Course	PAPER 1	Theory	4	48
	PAPER 2	Theory	4	48
	PAPER 3	Theory	4	48
	PAPER 4	Theory	4	48
Practical Laboratory Work & Viva-voce	PAPER 5	Practical	4	96
Geological Excursion/Field related Project work	PAPER 6	Field Training	4	96
Total			24	

Semester III

Course	Papers	Type	Credit	No. of Hours
Core Course	PAPER 1	Theory	4	48
	PAPER 2	Theory	4	48
	PAPER 3	Theory	4	48
	PAPER 4	Theory	4	48
Inter-departmental open Elective Course	PAPER 5	Theory	4	48
Practical Laboratory Work & Viva-voce	PAPER 6	Practical	4	96
Total			24	

Semester IV

Course	Papers	Type	Credit	No. of Hours
Core Course	PAPER 1	Theory	4	48
	PAPER 2	Theory	4	48
	PAPER 3	Theory	4	48
Freezed Elective	PAPER 4	Theory	4	48
Practical Laboratory Work & Viva-voce	PAPER 5	Practical	4	96
Geological Excursion/Field related Project work	PAPER 6	Field Training	4	96
TOTAL			24	

CORE COURSES

Paper Code	Type	Course Title	Credit	No. of Hours
Semester I				
AGC-11	Theory	Basics of Earth Sciences	4	48
AGC-12	Theory	Sedimentology	4	48
AGC-13	Theory	Stratigraphy	4	48
AGC-14	Theory	Mineralogy, Crystallography and Igneous Petrology	4	48
Semester II				
AGC-21	Theory	Structural Geology and Tectonics	4	48
AGC-22	Theory	Palaeontology	4	48
AGC-23	Theory	Metamorphic Petrology and Economic Geology	4	48
AGC-24	Theory	Petroleum Geology	4	48
Semester III				
AGC-31	Theory	Introduction of Geophysics	4	48
AGC-32	Theory	Sedimentary Basins	4	48
AG-C33	Theory	Exploration, Drilling, Production and Reservoir Engineering	4	48
AGC-34	Theory	Energy Resources and Geochemistry	4	48
Semester IV				
AGC-41	Theory	Well Logging	4	48
AGC-42	Theory	Sequence Stratigraphy	4	48
AGC-43	Theory	Indian Petroliferous Basins	4	48
AGC-44	Theory	Freezed Elective (Departmental Electives)	4	48

FREEZED ELECTIVES (DEPARTMENTAL ELECTIVES)

AGF-44-1	Theory	Environmental Geology	4	48
AGF-44-2	Theory	Engineering Geology and Groundwater	4	48
AGF-44-3	Theory	Climatology	4	48

PRACTICAL

Sem.	Paper Code	Type	Course Title	Credit	No. of Hours
Sem I	**AGP-11**	Practical	Basics of Earth Sciences, Sedimentology, Stratigraphy, Mineralogy, Crystallography & Igneous Petrology	4	96
Sem II	**AGP-21**	Practical	Structural Geology and Tectonics, Palaeontology, Metamorphic Petrology & Economic Geology, Petroleum Geology	4	96
Sem III	**AGP-31**	Practical	Geophysics and Seismic Interpretation, Sedimentary Basins, Exploration, Drilling, Production and Reservoir Engineering, Energy Resources and Geochemistry	4	96
Sem.IV	**AGP-41**	Practical	Well Logging, Sequence Stratigraphy, Indian Petroliferous Basins ,	4	96

FIELD EXCURSION

Sem.	Paper Code	Type	Course Title	Credit	No. of Hours
Sem II	AGT-21	**Geological Excursion/Field related Project work**	On site field training	4	96
Sem IV	AGT-41	**Geological Excursion/Field related Project work**	On site field training	4	96

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To be evaluated by the faculty members taking the students for geological excursion

ELECTIVE: INTER DEPARTMENTAL COURSE (FOR THE STUDENT OF SCIENCES)

Sem.	Paper Code	Type	Course Title	Credit	No. of Hours
Sem III	AGE-31	Theory	Remote Sensing and its application	4	48

M. Sc. IN APPLIED GEOLOGY
(With Specialization In Petroleum Geosciences)

COURSES		Internal Assessment Marks	Semester End Examination Marks	Total	
				Credits	Marks
SEMESTER I					
AGC-11	Basics of Earth Sciences	30	70	**4**	**100**
AGC-12	Sedimentology	30	70	**4**	**100**
AGC-13	Stratigraphy	30	70	**4**	**100**
AGC-14	Mineralogy, Crystallography and Igneous Petrology	30	70	**4**	**100**
AGP-11	**Practical:** Laboratory Work & Viva-voce			**4**	**100**
AGT-11	**Project work**			**4**	**100**
				24	**600**
SEMESTER II					
AGC-21	Structural Geology and Tectonics	30	70	**4**	**100**
AGC-22	Palaeontology	30	70	**4**	**100**
AGC-23	Metamorphic Petrology and Economic Geology	30	70	**4**	**100**
AGC-24	Petroleum Geology	30	70	**4**	**100**
AGP-21	**Practical:** Laboratory Work & Viva-voce			**4**	**100**
AGT-21	**Geological Excursion/Field related Project work**:Dissertation work, Field Related project work, Practical Training Including Case Study, Tutorials and Report Writing			**4**	**100**
				24	**600**
SEMESTER III					
AGC-31	Introduction of Geophysics	30	70	**4**	**100**
AGC-32	Sedimentary Basins	30	70	**4**	**100**
AGC-33	Exploration, Drilling, Production and Reservoir Engineering	30	70	**4**	**100**
AGC-34	Energy Resources and Geochemistry	30	70	**4**	**100**
AGE-31	**Inter Department Open Elective Remote Sensing and its application**	30	70	**4**	**100**
AGP-31	**Practical:** Laboratory Work & Viva-voce			**4**	**100**
				24	**600**
SEMESTER IV					
AGC-41	Well Logging	30	70	**4**	**100**
AGC-42	Sequence Stratigraphy	30	70	**4**	**100**
AGC-43	Indian Petroliferous Basins	30	70	**4**	**100**
AGF-44-1	Environmental Geology	30	70	**4**	**100**
AGF-44-2	Engineering Geology and Groundwater				
AGF-44-3	Climatology				
AGP-41	**Practical:** Laboratory Work & Viva-voce			**4**	**100**
AGT-41	**Geological Excursion/Field related Project work**:Practical Training Including Case Study, Tutorials and Report/ Dissertation Writing & Presentation.			**4**	**100**
				24	**600**

DETAILED SYLLABUS FOR FOUR SEMESTERS

M. Sc. Programme in Applied Geology (Four Semesters)
(With Specialization in Petroleum Geosciences)

FIRST SEMESTER

AGC-11 Basics of Earth Sciences

UNIT I
Introduction to Geology; Origin of Earth; Age of Earth, Interior of Earth, Radiometric dating methods of rocks; Geological time scale; Weathering and Erosion

UNIT II
Basic concept of Landform evolution; Exogenic processes: Fluvial, Aeolian, Glacial, Karst and Coastal; River basin and drainage network; Waves and Currents;

UNIT III
Earthquakes and Volcanoes; Forms of igneous bodies., Coral reefs; Active tectonics and associated landforms.

UNIT IV
Quaternary time; Climatic cycles during Quaternary; Milankovitch cycles; Use of Oxygen Isotopes in palaeoclimate studies.

UNIT V
Geomorphology and Quaternary climate studies of Thar Desert, Ganga Plain, Extra Peninsular India including Himalayas and Peninsular India;

Course outcome:
The course content provides the students with an over-all knowledge about how the earth came into being, when and how was it formed as also the different processes operative from time to time. The outcome of these operative processes in the form of different types of landforms and division of the Indian landmass into different physiographic units. The evolution of these landforms over time with the variations in climatic conditions is also an integral part of the course content. The various sub-divisions of the Indian landmass would also be better understood.

Suggested Readings:

1. Krishnan. M. S., 2017. Geology of India and Burma. C.B.S. Publishers & Distributors Pvt. Ltd., New Delhi.
2. Strahler, A., 2016. Introducing Physical Geography. Wiley India Pvt. Ltd., New Delhi.
3. Plummer, C.C., Carlson, D.H. and Hammersley, L., 2013. Physical Geology. Mc Graw Hill International Edition.
4. Meissner, R., 2002. The Little Book of Planet Earth. Springer-Verlag, New York, Inc.
5. Medina, P., 2005. Earth Science. C.B.S. Publishers & Distributors Pvt. Ltd., New Delhi
6. Lahee F.H., 1987. Field Geology. C.B.S. Publishers & Distributors Pvt. Ltd., New Delhi.
7. Morrison, W.G., 2004. A Dictionary of Geology. C.B.S. Publishers & Distributors Pvt. Ltd., New Delhi.
8. Putnis A. Introduction to Mineral Sciences, Cambridge publication, 1992
9. Neil Britt, 2011. Geology for Beginners: Beginners Guide To Geology, Kindle edition
10. Mathur, S.M.,2008. Elements of Geology, Published by PHI Learning

AGC-12 Sedimentology

UNIT I

Introduction to sedimentary rocks, Origin of sedimentary rocks, Classification of Sedimentary Rocks, Diagenesis and Lithification.

UNIT II

Fluid Dynamics, Laminar flow and turbulent flow, Reynold Number, Froude Number, Bed forms and flow regime

UNIT III

Texture of sedimentary rocks; Sedimentary structures, Primary. Depositional Sedimentary Environments

UNIT IV

Terrigenous clastics, and chemically precipitated rocks and their classification.

UNIT V

Concept of facies; Walther's Law of facies, General idea about shallow marine environments; Fluvial system; Delta system; Deep sea systems.

Course outcome:

The course content provides the students with an over-all knowledge about how the different types of sedimentary rocks are formed. With the different hydrodynamic processes operative in the regime, the sediments start moving and getting deposited as sedimentary rocks. During the process, the internal as also the external characteristics of sedimentary rocks vary, which are analysed to tell about the environment of deposition. The course content specifies the study of different sedimentary structures, both internal and external as also the depositional environments. The subsequent variations in sedimentary rocks are also studied.

Suggested Readings:

1. Prothero, Donald R., 2013. Sedimentary Geology: An Introduction to Sedimentary Rocks and Stratigraphy. W. H. Freeman; Third edition
2. Reading, H.G., 2009. Sedimentary Environments: Processes, Facies and Stratigraphy. John Wiley & Sons.
3. Sengupta, S.M., 2018. Introduction to Sedimentology. CBS Publishers & Distributors Pvt. Ltd.
4. Leeder, Mike, 2009. Sedimentology and Sedimentary Basins: from Turbulence to Tectonics. John Wiley & Sons.
5. Gokhale, N.W., 2017. Fundamentals of Sedimentary Rocks. CBS Publishers & Distributors Pvt. Ltd.
6. Allen, P.A., 1997. Earth Surface Processes, Blackwell publishing.
7. Reineck, H.E. and Singh IB, 1980. Depositional Sedimentary Environments: With Reference to Terrigenous Clastics, Springer.
8. Collinson, J.D. and Thompson, D.B., 1988. Sedimentary Structures, UnwinHyman, London.
9. Hsu, K.J., 2004. Physics of Sedimentology, Springer Verlag, Berlin.
10. Leeder, M.R., 1982. Sedimentology: Process and Product. George Alien&Unwin, London, 344p.
11. Lindholm, R.C., 1987. A Practical Approach to Sedimentologv, AllcnaneUnwin, London.
12. Pettijohn, F.J., 1975. Sedimentary Rocks, Harper and Row Publ. New Delhi.
13. Prothoreo and Schwab, 2004. Sedimentary Geology, Freeman
14. Miall, A.D., 1999. Principles of Sedimentary Basin Analysis 3 rdFdSpringer Verlag, New York.
15. Nichols, G., 1999. Sedimentology and Stratigraphy, Blackwell publishing.
16. Sam Boggs, 1995. Principles of Sedimentology and Stratigraphy, Print iceHall, New Jersey.
17. Tucker, M.E., 2006. Sedimentary Petrology. Blackwell Publishing.

AGC-13 Stratigraphy

UNIT I

Principles of stratigraphy: Lithostratigraphic, Magnetostratigraphic, Chronostratigraphic and Biostratigraphic units; Stratigraphic correlation; Physical and structural subdivisions of the Indian subcontinent and their characters.

UNIT II

Precambrian time and important events. Precambrian stratigraphy of India with special reference to Vindhyan, Cuddapah and Dharwar Supergroups.

UNIT III

Palaeozoic time and important events. Palaeozoic stratigraphy of Himalayas with special reference to Spiti valley, H.P., Mesozoic time and important events; Triassic stratigraphy of Himalaya with special reference to Spiti valley, H.P.. Jurassic stratigraphy of western India with special reference to Kutch and Rajasthan.

UNIT IV

Non-marine Palaeozoic and Mesozoic stratigraphy of India with special reference to Gondwana Super Group and Deccan traps.

UNIT V

Marine and non-marine Cretaceous formations of India. Siwalik Group of India with special reference to Lithostratigraphy, Vertebrate Palaeontology and Magnetostratigraphy. Boundary problems – Cretaceous-tertiary boundary, Neogene-Quaternary boundary, Palaeogene and Neogene global events

Course outcome:

The sequence of deposition of stratigraphic horizons over period of time since the time the earth came into being upto the present time is all studied within this syllabus. The characteristics of each of these stratigraphic sequences is dealt with in detail. The fossils characteristic of each of these stratigraphic horizons is also studied.

Suggested Readings:

1. Doyle, P. and Bennett, M.R., 1996. Unlocking the Stratigraphic Record, John Willey.
2. Dunbar, C.O. and Rodgers, J., 1957. Principles of Stratigraphy. John Wiley & Sons.
3. Krishnan, M.S., 1982. Geology of India and Burma, C.B.S. Publishers, Delhi
4. Naqvi, S.M. 2005. Geology and Evolution of the Indian Plate: From Hadean to Holocene4 Ga to 4 Ka. Capital Pub., New Delhi.
5. Pascoe, E.H., 1968. A Manual of the Geology of India & Burma (Vols.IN), Govt. of India Press, Delhi.
6. Pomerol, C., 1982. The Cenozoic Era - Tertiary and Quaternary. Ellis Harwood Ltd., Halsted Press.
7. Schoch, R.M., 1989. Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York. 9.
8. Vaidyanathan, R. & Ramakrishnan, M., 2008. Geology of India, Geological Society of India.

AGC-14 Mineralogy, Crystallography and Igneous Petrology

UNIT I

Polarising microscope; Physical and optical properties of minerals; Solid solution, polymorphism, isomorphism and pseudomorphism; Pauling's rules and coordination polyhedral.

UNIT II

Crystal forms; Twinning in crystals; Zoning; Crystal defects; Silicate structures; Study of normal class of cubic, tetragonal, hexagonal, orthorhombic, monoclinic and triclinic systems.

UNIT III
Detailed study of following mineral groups with reference to their general formula, classification, atomic structure, paragenesis and uses: Silica group, Feldspar group and Feldspathoid group, Pyroxene group, Amphibole group

UNIT IV
Detailed study of following mineral groups with reference to their general formula, classification, atomic structure, paragenesis and uses: Garnet group, Olivine group, Mica group, Zeolite group, Introduction to structures of clay minerals.

UNIT V
Magma: definition, composition and origin; Bowen's reaction series; Classification of igneous rocks; Textures and structures of igneous rocks; Magmatic evolution (differentiation, assimilation, mixing, mingling); Types of magma melting; Phase equilibria studies; Classification and composition of meteorites; Petrology and petrogenesis of igneous rocks.

Course outcome:
The formation of different group of minerals under different set of physical and chemical conditions is studied in detail. Different temperature and pressure regimes have resulted in formation of different mineralised zones which are understood during course of these studies. The different mineral families, their formations and occurrences are understood in detail.

Suggested Readings:

1. Paul F. Kerr, 2014. Optical Mineralogy. McGraw Hill Education (India) Pvt. Ltd.
2. John D. Winter, 2018. Principles of Igneous and Metamorphic Petrology. Pearson India Education Services Pvt. Ltd.
3. Dexter Perkins, 2016. Mineralogy. Pearson India Education Services Pvt. Ltd.
4. Hota, Rabindra Nath, 2017. Practical Approach to Crystallography and Mineralogy. CBS Publishers & Distributors Pvt. Ltd.
5. Ernest G. Ehlers and Harvey Blatt, 1999. Petrology: Igneous Sedimentary and Metamorphic. CBS Publishers & Distributors Pvt. Ltd.
6. Cornelis Klein and Anthony R. Philpotts. 2017. Earth Materials: Introduction to Mineralogy and Petrology. Cambridge University Press.
7. Putnis, A. 1992. Introduction to Mineral Sciences, Cambridge publication.
8. Cornelis Klein and Barbara Dutrow, 2007. The manual of Mineral Science, Wiley Publication
9. Cox, K.G., Bell, J.D. and Pankhurst, R.J. 1979. Interpretations of igneous rocks. George Allen and Unwin, London.
10. Wilson, M. 1989. Igneous Petrogenesis. London Unwin Hyman.
11. Anthony R. Philpotts and Ague, J.J. 2009. Principles of Igneous and Metamorphic Petrology. Cambridge.
12. Sen, Gautam, 2014. Petrology: Principles and Practice: Gautam Sen (Springer).
13. Best, M.G. 2013. Igneous and Metamorphic Petrology. Wiley Blackwell.
14. Don L. Anderson, 2012 Theory of the Earth Blackwell Scientific Publications
15. Alexander R. McBirney, 2006 Igneous Petrology, III edition: Alexander R McBirney

AGP-11 Laboratory work and Viva -Voce

Laboratory exercises related to Basics of earth sciences, Sedimentology, Mineralogy, Crystallography, Optical Mineralogy and Igneous Petrology.

Every student shall be required to keep and maintain up-to-date record of practical work during the session, properly signed by the teachers concerned and submit it at the time of their Practical Examination.

Outcome:
It provides the students with the overall practical knowledge of the entire gamut of subjects

studied in the first semester. Practical classes relating to solving the structural problems. Identifying the physical and chemical properties etc of igneous, sedimentary rocks and the minerals in hand specimens and also under microscope form part of the exposure to students in the first semester.

AGT-11 Project work

For the project work, students would be required to prepare and submit a write-up and give a Power Point Presentation on a topic/ project assigned to them.
The marks awarded for the Project work shall be on the basis of the write-up and presentation

Course Outcome:
It provides the students with the opportunity to prepare a detailed report on any of the topics relating to each of the four theoretical papers covered during the semester. These reports are evaluated and the student is also required to make a power point presentation of the work compiled.

M. Sc. Programme in Applied Geology (Four Semesters)
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SECOND SEMESTER

AGC-21 Structural Geology and Tectonics

UNIT I
Introduction to structural geology; Crustal processes, behaviour of the crust during deformation; Mechanical properties of rocks; Concepts of stress and strain; Mohr diagrams; Estimation of strain in naturally deformed rocks.

UNIT II
Sea-floor spreading; Concepts of plate-tectonics; Causes of Plate motion; Mantle Plumes and Plume mechanics

UNIT III
Outliers and Inliers; Unconformities: their classification, recognition and geological significance, onlap and offlap; Morphology, Geometric and genetic classification of Folds and Faults their Recognition in the field and their effects on beds.

UNIT IV
Joints; Foliation and Lineation; Recognition of top and bottom of beds; Time relationships between crystallisation and deformation. Neotectonics.

UNIT V
Shear zones; Geometry and rock types of shear zones; Types of Tectonites; Structure and tectonic evolution of the Himalaya; Anatomy of Mountain belts.

Course outcome:
The forces operative on the surface of earth all through it's existence have resulted in major modifications from time to time. These forces are operative not only on the surface of earth but are equally operative underneath the sea surface also. These modify the face of the earth. The course content elaborates these various processes and the products. The students are provided detailed knowledge about each of these facts so that they may better understand the formation of the present face of the earth.

Suggested Readings:

1. Bruce Hobbs and Alison Ord, 2015. Structural Geology: The Mechanics of Deforming Metamorphic Rocks. Volume 1: Principles. Elsevier
2. Marland P. Billings, 2016, Structural Geology. Perarson India Education Services Pvt. Ltd.
3. Fossen, H., 2016. Structural Geology. Cambridge University Press.
4. Bailey, B., 1992. Mechanics in Structural Geology, Springer.
5. Davis, G.H. and Reynolds, S.J., 1996. Structural Geology of rocks and regions, John Wiley. and Sons.
6. Ghosh, S.K., 1993. Structural Geology: Fundamentals, and modern developments, Pergamon Press.
7. Leyson, P.R. and Lisle, R.J., 1996. Stereographic projection techniques in structural geology, Cambridge University Press.
8. Passhier, C. and Trouw, R.A.J., 2005. Microtectonics. Springer, Berlin.
9. Pollard, D.D. and Fletcher, R.C., 2005. Fundamentals of structural geology, Cambridge University Press.
10. Ramsay, J.G. and Huber, M.I., 1983. Techniques of Modern Structural Geology: vol.I & II. Academic Press.
11. Ramsay, J.G., 1967. Folding and Fracturing of Rocks, McGraw-Hill Book Company, New York.

12. Rowland, S.M., Duebendorier, E. and Schiefelbein, I.M., 2007. Structural analysis and synthesis: a laboratory course in structural geology, Balckwell pub.
13. Suppe, J., 1985.The Principles of Structural Geology, Prentice-Hall, Inc., New Jersey,.
14. Twiss, R.J. and Moores, E.M., 2007. Structural Geology. Freeman.
15. Van der Pluijm, B.A. and Marshak, S., 2004. Earth structure: an introduction to structural Geology.

AGC-22 Palaeontology

UNIT I
Introduction to palaeontology; processes of fossilisation; Origin of life and Precambrian fossil records; Basic idea of trace fossils and their uses.

UNIT II
Morphology and mode of life in brief of Bivalvia, Gastropoda, Brachiopoda, Cephalopoda,

UNIT III
Morphology and mode of life in brief of Echinoidea and Anthozoa, Trilobita and Graptolithina;

UNIT IV
Introduction to various microfossil groups. Micropalaeontology and its use in hydrocarbon Exploration.

UNIT V
Evolution of important vertebrates and their fossils localities in India; Siwalik Vertebrate fauna. Devonian flora, Gondwana flora, and Deccan Inter-trappean flora.

Course outcome:
The origin of the earth and it's evolution has also witnessed the origin and evolution of life in different forms. The study of these different types of life as also their evolution with time is an integral part of the syllabus. Different life types right from microscopic to the vertebrate life along with their evolution with time is understood by the students. Different geological time periods are characterised with different types of life and this is also part of the course material.

Suggested Readings:
1. Moore, Raymond C., Lalicker, Cecil G. and Fischer, Alfred G., 1952. Invertebrate Fossils. McGraw-Hill Book Co., Inc. USA.
2. Shrock, Robert, R. and Twenhofel, William H.. 2005. Principles of Invertebrate Paleontology. McGraw-Hill Book Co., Inc. USA.
3. Cowen, R., 2000. History of Life, Blackwell Science.
4. E. N. K. Clarkson (2013). Invertebrate palaeontology and Evolution, Blackwell Science
5. Black, R.M., 1989. The Elements of Palaeontology, Cambridge University Press
6. Benton, Michael, 2005. Vertebrate Palaeontology, Blackwell Publishing
7. Jackson, Patrick Wyse, 2019, Introducing Palaeontology: A Guide to Ancient Life, Dunedin Academic Press Ltd.
8. Raymond Enay, 2012. Palaeontology of Invertebrates, Springer-Verlag.
9. Peter Doyle, Understanding Fossils: An Introduction to Invertebrate Palaeontology.
10. Morley Davies, 2008. An Introduction to Palaeontology, Read Books.
11. Jain, Sreepat, 2017. Fundamentals of Invertebrate Palaeontology: Macrofossils, Springer India
12. Goldring, Roland, 2014. Field Palaeontology, Routledge
13. Saraswati, Pratul Kumar and Srinivasan, M.S., 2016. Micropaleontology: Principles and Applications, Springer International Publishing Switzerland.
14. Michael Benton, David A. T. Harper, 2009. Introduction to Paleobiology and the Fossil Record, Wiley-Blackwell.

AGC-23 Metamorphic Petrology and Economic Geology

UNIT I

Metamorphism: controlling factors and types of metamorphism; metamorphic grades; structures and textures of metamorphic rocks; Mineralogical phase rule for closed and open systems; Nature of metamorphic reactions; Graphic representation of mineral assemblages (ACF, A'KF and AFM projections); Concept of P-T-t paths; Geothermobarometry.

UNIT II

Concept of metamorphic zones, index minerals, Isograds and reaction isograds; Concept and classification of metamorphic facies and facies series; Metamorphism of pelitic rocks.

UNIT III

Regional metamorphism and its relation to plate tectonics; Paired metamorphic belts; Metasomatism and metamorphic differentiation.

UNIT IV

Introduction to ultrahigh temperature and ultrahigh pressure metamorphism; Petrogenesis of Charnockite; Anatexis; Origin and structure of migmatites.

UNIT V

Processes of formation of ores; Occurrence, origin and distribution of the important metallic and non-metallic mineral deposits of India; Manganese nodules; Concepts of mineral exploration; Concepts of surface and subsurface mining; Strategic, Critical and Essential minerals; National Mineral Policy; Mineral Concession Rules.

Course outcome:

The changes in rock types over period of time as a result of varying temperature and pressure regimes have resulted in formation of metamorphic type of rocks. The details about the processes and the products is understood by the students. The economically viable deposits are important for the developmental activities and these economic mineral deposits are also studied during course of this semester.

Suggested Readings:

1. Best, M.G., 2013. Igneous and Metamorphic Petrology. Wiley Blackwell.
2. Barker, A.J., 2004, Introduction to Metamorphic Textures and Microstructures, Routledge.
3. Bucher, K. and Grapes, R., 2011, Petrogenesis of Metamorphic Rocks, Springer.
4. Mason, R., 1990. Petrology of the Metamorphic Rocks, Unwin Hyman Ltd.
5. Philpotts, A. and Ague, J., 2009. Principles of Igneous and Metamorphic Petrology, Cambridge University Press.
6. Spear, F.S., 1993. Metamorphic Phase Equilibria and Pressure–Temperature–Time Paths, Mineralogical Society of America.
7. Vernon, R.H. and Clarke, G.L., 2008. Principles of Metamorphic Petrology, Cambridge University Press.
8. Winter, J.D., 2009. Principles of Igneous and Metamorphic Petrology, Pearson.
9. Yardley, B.W.D., 1996. An introduction to Metamorphic Petrology, Prentice Hall.
10. Yardley, B.W.D., MacKenzie, W.S. and Guilford, C., 1990. Atlas of Metamorphic Rocks and their textures, Longman Scientific & Technical.
11. Ridley, John., 2013. Ore deposit geology. Cambridge University Press.
12. Mookherjee, A., 2000. Ore Genesis – A Holistic Approach. Allied Publisher.
13. Pracejus, Bernhard, 2015. The ore minerals under the microscope: an optical guide. Vol. 3. Elsevier.
14. Moon, C.J., Michael, K.G. Whateley and Anthony M. Evans. (Editors), 2012. Introduction to Mineral Exploration. Blackwell Publishing. Wiley India Pvt. Ltd.
15. Walter L. Pohl, 2016. Economic Geology Principles and Practice. Wiley India Pvt. Ltd.
16. Prasad, Umeshwar, 2018. Economic Geology: Economic Mineral Deposit. CBS Publishers & Distributors Pvt. Ltd.

AG-24 Petroleum Geology

UNIT I

Basics of Hydrocarbon Geology; Crude oils and Petrochemical raw materials; Physical and Chemical characteristics of Hydrocarbons

UNIT II

Generation of Hydrocarbon, Kerogen, Reservoir characteristics, Primary and Secondary Migration of Hydrocarbons

UNIT III

Structural, Stratigraphic and Combination traps; Growth Structures.

UNIT IV

Exploration of Petroleum; Introduction to well-logging;

UNIT V

Oil production methods; New Resources of Hydrocarbons: Gas Hydrates, Coal Bed Methane, Shale Gas.

Course outcome:

The course content provides the basic knowledge about the formation, occurrence and present distribution of petroleum products. Their mode of formation, the manner in which they migrate and the traps in which they get accumulated are all understood by the students. The manner in which these hydrocarbons are distributed and how are they studied for exploitation are all part of the course material.

Suggested Readings:

1. North, F.K., 1985. Petroleum geology Petroleum Geology. Published by Kluwer Academic Publishers.
2. Levorsen, A.I., 2001. Geology of Petroleum AAPG SPECIAL PUBLICATION. American Association of Petroleum Geologists.
3. Chapman, R.E., 2004. Petroleum Geology, Elsevier
4. Selly, Richard C. Elements of Petroleum Geology

AGP-21 Laboratory work and Viva -Voce

Laboratory exercises related to Structural Geology, Palaeontology, Metamorphic Petrology, Economic Geology and Petroleum Geology.

Course Outcome:

It is the practical understanding of all that is studied in the II semester. Problems relating to structural geology, the metamorphic petrology, economic geology and the fossil remains are all taken up during the practical classes. The basic problems of petroleum geology are also learnt during this semester.

AGP-21 Field work/Dissertation Project work

Every student shall be required to attend the field training/dissertation work and submit a record of field observations and specimens collected, properly labelled after returning from the field.

Viva–Voce examination based on the field work shall also be conducted at the time of the Practical Examination or separately.

The marks assigned to the fieldwork/dissertation work shall be on the basis of the field records and collections, and performance in the field.

Course Outcome:

It is an important component as it deals with the field exposures. The students are given first hand knowledge about the field work in different types of terrains. Subsequently, the students are required to compile the field report and make presentation on what they have learnt in the field.

M. Sc. Programme in Applied Geology (Four Semesters)
(With Specialization in Petroleum Geosciences)

SEMESTER III

AG-31 Introduction of Geophysics

UNIT I
Introduction of Geophysics and Geophysical methods in exploration and mining; Earth shape: Geoid; Internal structure of Earth and seismic Discontinuities.

UNIT II
Gravity and magnetic methods: Fundamental of Gravity, Gravity anomalies, Magnetism and magnetic fields, Magnetic properties of rocks, Palaeomagnetism, Magnetic anomalies.

UNIT III
Electrical Resistivity Methods: Basic principles of resistivity, Spontaneous (Self) Potential Methods and Induced Polarisation; Electrode configurations and geometric factors, Modes of deployment: VES, ERT, and CST and Electromagnetic Method.

UNIT IV
Seismic Method: fundamental of Seismic waves, Loss of seismic energy, Detection and recording of seismic waves; Seismic Refraction Surveying and Seismic Reflection Surveying, Velocity Measurements: in boreholes, by surface- to surface refraction

UNIT V
Fundamentals of Geophysical Instruments: Gravimeter, Magnetometer, Resistivity meter, Geophone, Ground Penetrating Radar

Course outcome:
The different methods and techniques by which the minerals and hydrocarbons are studied for eventual exploitation is important. The various method by which these could be studied for their occurrence and also estimation of their reserves is variable depending upon the geographic and geological location. An idea about the different methods and their applicability is provided as a part of this syllabus.

Suggested Readings:

1. Milsom, John and Eriksen, Asger, 2015. Field Geophysics.Wiley Blackwell.
2. Dobrin, M.B and Savit, C.H., 1988. Introduction to Geophysical Prospecting, McGraw Hill.
3. Grant, F.S. and West, G.F., 1965. Interpretation Theory in Applied Geophysics McGraw Hill, New York.
4. Murthy, L.Y.R. and Mishra, D.C., 1989. Interpretation of Gravity and Magnetic Anomalies in Space and Frequency Domain, AEG publication, Hyderabad, India
5. Nettleton, L.L., 1976. Gravity and Magnetics in Oil Prospecting, McGraw Hill.
6. Parasnis, D.S., 1966. Mining Geophysics, Elsevier.
7. Telford, W.M., Geldart, L.P. and Sheriff, R.E., 1990. Applied Geophysics, Cambridge
8. Lowri, W., Fundamentals of Geophysics, Cambridge University Press.
9. Mussett, Alan E., Khan, M.A., 2000. Looking into the earth: An introduction to geological geophysics, Cambridge University Press.
10. Telford, W.M., Geldart, L.P. and Sheriff, R.E., 1990. Applied geophysics. Cambridge University Press.
11. Mussett, A.E. and Khan, M.A., 2017. Looking Into the Earth. Cambridge University Press, New York, NY, USA.
12. Avseth, P., Mukerji, T. and Mavko, G., 2014. Quantitative Seismic Interpretation: Applying Rock Physics Tools to Reduce Interpretation Risk. Cambridge University Press.
13. Anstey, N.A., Seismic Interpretation: The Physical Aspects. International Human Resources Development Corporation

AGC-32 Sedimentary Basins

UNIT I
Introduction to Sedimentary Basins, Concepts, Scope and Importance of Sedimentary Basins, Genesis of Sedimentary Basins

UNIT II
Classification of Sedimentary Basins; Types of basins related to lithospheric extension, Basins formed by subduction of plates

UNIT III
Basins formed by strike-slip movement, Complex, hybrid and Miscellaneous basins

UNIT IV
Analysis of Sedimentary basins, modern examples of sedimentary basins

UNIT V
Basin Stratigraphy, Basin Modelling.

Course outcome:
It imparts detailed knowledge about the different sedimentary basins of India vis-à-vis their importance in oil explorations. How the sedimentary basins are formed and how are they classified, analysed and modelled forms integral part of the syllabus.

Suggested Readings:

1. Sam Boggs J.R., 2016. Principles of Sedimentology and Stratigraphy. Pearson India Education Services Pvt. Ltd.
2. Allen, P.A. and Allen, J.R., 2013. Basin Analysis: Principles and Application to Petroleum Play Assessment. Books.google.com. Wiley- Blackwel
3. Levorsen, A.I., 2001. Geology of Petroleum. American Association of Petroleum Geologists Special Publication.
4. Prothero, Donald R., 2013. Sedimentary Geology: An Introduction to Sedimentary Rocks and Stratigraphy. W. H. Freeman; Third edition
5. Pearson, Sam Boggs, 2016. Principles of Sedimentology and Stratigraphy. 5th Edition, Pearson.
6. Reading, H.G., 2009. Sedimentary Environments: Processes, Facies and Stratigraphy. John Wiley & Sons.
7. Leeder, Mike, 2009. Sedimentology and Sedimentary Basins: from Turbulence to Tectonics. John Wiley & Sons.
8. Gokhale, N.W. Fundamentals of Sedimentary Rocks.

AGC-33 Exploration, Drilling, Production and Reservoir Engineering

UNIT I
Drilling Rigs, types and components.

UNIT II
Drilling fluid types and uses. Types of wells. Drilling Engineering – observation and interpretation.

UNIT III
Well prognosis and Drilling program; General drilling information; Tools and techniques used in Drilling.

UNIT IV
Mudlogging and various drilling operations; Pressure evaluation while drilling; Well Site Geological techniques.

UNIT V
Basics of Reservoir Engineering; Concept of Enhanced Oil Recovery; Techniques of Enhanced Oil Recovery (EOR); Planning of Enhanced Oil Recovery.

Course outcome:
The course content provide a complete knowledge about the different techniques of exploration and exploitation of oil and gas resources. The various drilling techniques and enhancement of production outputs are also part of the syllabus. The planning of exploration wells and the engineering techniques employed to enhance the production also form an integral part of the syllabus.

Suggested Readings:

1. Fanchi, J.R. and Christiansen, R.L., Introduction to Petroleum Engineering. John Wiley & Sons Inc
2. Boyun, Guo, Xinghui, Liu and Xuehao, Tan, 2017. Petroleum Production Engineering. Elsevier. Imprint: Gulf Professional Publishing
3. William Lyons, Gary Plisga, BS and Michael Lorenz (Ed.), 2015.Standard Handbook of Petroleum and Natural Gas Engineering. Imprint: Gulf Professional Publishing.
4. Leverson, A.L., Geology of Petroleum. Revised and Edited by Frederick A.F. Berry, University of California, Berkeley.
5. Prasad, Ram, 2002. Petroleum Refining Technology. Khanna Publisher

AGC-34 Energy Resources and Geochemistry

UNIT I
Sustainable Environmental studies; Fossil fuels; Solar Energy, Hydro Energy, Ocean Energy, Wind Energy, Geothermal Energy, Biomass, Nuclear Energy;

UNIT II
Storage of Energy; Energy Scenario in India; Energy Audit; Global pricing and Geopolitics and its importance on economics**.**

UNIT III
Introduction of Geochemistry; Geochemistry of the atmosphere, hydrosphere, lithosphere; Geochemistry of sedimentary rocks; Geochemical cycle: Carbon cycle and Oxygen cycle.

UNIT IV
Isotopic fractionation, Stable Isotopes with special reference to oxygen and carbon isotopes; Radiogenic Isotopes.

UNIT V
Goldschmidt's Geochemical classification, Geochemical differentiation; Major, minor, trace and Rare Earth Elements.

Course outcome:
The course content provides an overall knowledge about the renewable and non-renewable sources of energy, their exploration and exploitation methods and means of their proper utilisation for the benefit of mankind. The energy scenario in India and overseas along with the trends in global pricing policies provide a totality of knowledge in the energy sector. The geochemical properties of different types of energy resources is also imparted to provide a complete knowledge base to the students.

Suggested Readings:

1. Khan, 2017. Non-Conventional Energy Resources. McGraw Hill Education India Private Limited; Third edition (1 July 2017)
2. Viswanathan, B., 2016. Energy Sources. 1st Edition. Elsevier
3. Albarède, F., 2009. Geochemistry: An Introduction. Cambridge University Press.
4. White, W.M., Geochemistry. Wiley-Blackwell.
5. Krauskopf, K.B. and Bird, D.K., 1967. Introduction to geochemistry. McGraw-Hill Book Company.
6. Gill, R. Editor. Modern Analytical Geochemistry: An Introduction to Quantitative Chemical Analysis Techniques for Earth, Environmental and Material Scientists. Taylor & Francis, London & New York.
7. Twidell, John and Weir, Tony, 2015. Renewable Energy Resources. CRC Press Book, 3rd Edition.
8. Ghosh, T. and Mark, P., 2009. Energy Resources and Systems. Volume 1: Fundamentals and Non-Renewable Resources.
9. Baby Professor, 2017. An Introduction to Renewable Energy Sources : Environment Publisher: Baby Professor (May 15, 2017)

AGE-31 Inter-departmental Open Elective Course

Remote Sensing and its application

UNIT I
Basics of Remote Sensing; Physics of Remote Sensing, EMR Characteristics, Interaction of EMR in atmosphere and with ground objects; Interpretation elements

UNIT II
Types of Platforms, Sensor types and their characteristics; types of resolution

UNIT III
Remote Sensing satellites and data products; Satellite orbits and characteristics;

UNIT IV
Application of remote sensing in natural resources management / Geo-Sciences

UNIT V
Basics of GIS and GPS. Advanced Remote Sensing techniques.

Course Outcome:
The course provides an overall knowledge about the remote sensing techniques, the different types of sensors and the satellites, their resolutions, orbits and other characteristics. The application of remote sensing techniques in different natural resources exploration, exploitation and management programs, specifically in the domain of geo-sciences. The course content also highlights the introduction of the new techniques of GIS and GPS. Basics of Advanced techniques would also be provided to complete the newer developments in the technology.

Suggested Readings:

1. Thomas M. Lillesand & Palph W .Kiefer ,Remote Sensing and Image Interpretation
2. Paul R. Wolf & Bon A. Dewitt, Elements of Photogrammetry with application in GIS
3. Ravi P. Gupta Remote Sensing Geology
4. Basudeb Bhatta, Remote Sensing and GIS

5. Noam Levin, Fundamental of Remote Sensing
6. Floid F.Savins, Remote Sensing, Principal and Interpretation
7. Kiser, David P Paine, and James D Aerial Photography and Image interpretation second edition 2003, John Wiley and Sons Inc. ISBN 0-471-20489-7
8. TE Avery, Interpretation of Aerial Photographs:
9. W. Kilford , Elementary Air Survey
10. Manual of Photogrammetry: ASP Falls Church Virginia.
11. Modern Photogrammetry by Edward M Mikhail
12. Photogrammetry Vol. I- Kranss
13. Fundamentals of Remote Sensing: George Joseph
14. Lillesand & Keifer , Remote Sensing and Image Interpretation
15. Manual of Remote Sensing: ASP Falls Church Virginia USA.
16. PJ Curran, Physical aspects of Remote Sensing:.
17. F.F. Sabins , Remote Sensing Principles and Interpretation
18. J.B. Campbell, Introduction to Remote Sensing
19. John R Jensen, Introductory Digital Image Processing: A Remote Sensing Perspective

AGP-31 Laboratory work and Viva -Voce

Laboratory exercises related to Geophysics and Seismic Interpretation, Sedimentary Basins, Sequence Stratigraphy, Energy Resources.

Every student shall be required to keep and maintain up-to-date record of practical work during the session, properly signed by the teachers concerned and submit it at the time of their Practical Examination.

Couse Outcome:
It is the Laboratory work relating to the practical exercises of geophysical and seismic interpretations, sedimentary basins, sequence stratigraphy, remote sensing and groundwater.

M. Sc. Programme in Applied Geology (Four Semesters)
(With Specialization in Petroleum Geosciences)

Semester IV

AGC-41 Well Logging

UNIT I
MWD: Introduction and benefits, tool quality control. MWD Telemetry systems and Sensor types. Special Hydraulic considerations, Comparison with Wireline logging.

UNIT II
Theoretical Basis of well logging logging, Methods and Apparatus usedin well logging, Factors affecting results of well logging,

UNIT III
Horizontal wells and multilaterals, Geosteering: Application and uses, Well placement, case studies.

UNIT IV
Gamma ray log, SP log, Resistivity Log, Density porosity log, Sonic log, Pressure log

UNIT V
Interpretation of Well logs. Application of well logging in petroleum geosciences.

Course outcome:
The course content provides a basic knowledge about the logging of oil and gas wells so as to properly assess the productivity potential of the wells. The different ways of working out the economics of wells is also part of the knowledge base provided to the students, so that the students may readily use the knowledge in their professional carriers.

Suggested Readings:

1. Serra, L. and Serra, O., 2004. Well Logging and Geology. Publisher: Editions Technips.
2. Asquith, G. and Gibson, C.,1982. Basic Well Log Analysis for Geologists. Publisher: Amer Assn of Petroleum Geologists.
3. Bateman, R.M., 1986. Open Hole Log Analysis and Formation Evaluation. Publisher: Springer.
4. Ellis, Darwin V. and Singer, Julian M., 2007. Well Logging for Earth Scientists. Publisher: Springer.
5. Seera, O., 2008. Well Logging Handbook. Publisher: Editions Technips.
6. Bassiouni, Zaki, 2016. Theory, measurement, and interpretation of well logs. Publisher: Society of Petroleum Engineers, Inc.
7. Liu, C. Richard., 2017. Theory of Electromagnetic Well Logging. Publisher: Elsevier.
8. Serra, L. and Seera, O., 2004. Well Logging and Geology. Publisher: Editions Technips. Serra, L., 2007. Well Logging and Reservoir Evaluation. Publisher: Editions Technips (September 1, 2007)
9. Jonathan Evenick C., 2008. Introduction to Well Logs and Subsurface Maps. Publisher: PennWell Corp.

AGC-42 Sequence Stratigraphy

UNIT I
Introduction and concepts of Sequence Stratigraphy; Walther's law; Sea-level in geological history.

UNIT II
Types of stratigraphical cycles; Long Term Eustacy; Transgression; Regression: Normal and Forced Regression.

UNIT III
Para-sequences: Aggradational, Progradational, Retrogradational and Degradational Shoreline Shift and facies variation with the rise and fall in sea-level.

UNIT IV
Modern Sequence Stratigraphy, with special reference to Ganga delta.

UNIT V
Low System Tract, High System Tract, Transgressive System Tract; Sequence Boundaries; Maximum Flooding Surfaces.

Course outcome:
The understanding of the sequence of stratigraphic successions is important in oils studies. The manner in which different types of successions are formed, their nomenclatures and their genesis vis a vis the sea levels changes are part of the syllabus. Some case studies of important sedimentary sequences in India and abroad ara also taught so as to provide a vivid picture of the sequence stratigraphy in different set-ups.

Suggested Readings:

1. Catuneanu, O., 2006. Principles of Sequence Stratigraphy. Elsevier Science
2. Emery, D. and Myers, K. (Editors), 1996. Sequence Stratigraphy. Wiley Online Library.
3. Sam Boggs Jr., 2010. Principles of Sedimentology and Stratigraphy. Publisher: Pearson.
4. Miall, A.D., 2010. The Geology of Stratigraphic Sequences. Publisher: Springer .
5. Reineck, H.E. and Singh, I.B. 1986. Depositional Sedimentary Environments: With Reference to Terrigenous Clastics (Springer Study Edition), Springer; 2nd rev. and updated ed. 1980. Corr. 2nd printing edition (1 July 1986)
6. Miall, A.D., 2016. Stratigraphy: A Modern Synthesis. Springer.
7. Leckie, D.A. and James, D.P. 1988. Sequences, Stratigraphy, Sedimentology: Surface and Outcrop. Publisher: Canadian Society of Petroleum Geologists.

AGC-43 Indian Petroliferous Basins

UNIT I
Basics of Petroliferous Basins; History of petroleum geology in India; Petroleum products.

UNIT II
Assam Basin, Cambay Basin, Cauvery Basin, Tripura Basin.

UNIT III
Mahanadi Basin, Mumbai Offshore Basin, Rajasthan Basin, Krishna- Godavari Basin.

UNIT IV
Prospects of new petroleum basins in India;

UNIT V

Case Studies of Indian Sedimentary Basins.

Course outcome:
The course content provides an overall knowledge about the different petroliferous basins in the country. This would go a long way in helping the students in their future professional carriers.

Suggested Readings:

1. Bhandari, L.L. (Editor), 1983. Petroliferous Basins of India. KDM Institute of Petroleum Exploration Himachal Times Group, 1983.
2. Zutshi, P. L. and Panwar, M.S. , 1997. Geology of petroliferous basins of India. Publisher KDM Institute of Petroleum Exploration

Freezed Elective

AGF-41 Environmental Geology

UNIT I
Introduction, Environmental dilemmas, fundamental concepts of environmental geology. Environmental protection – legislative measures in India

UNIT II
Chemistry of green house gases, emission of Co2, consequences of green house gases, control and remedial measures, global warming a serious threat, global warming caused by CO2 increase in present atmosphere due to indiscrete exploitation of fossil fuels

UNIT III
The concept of earth system cycles in earth system- The energy cycle (energy inputs, solar radiations, geothermal energy, tidal –energy). The rock cycles (heat transfer in earth, plate tectonics and earth's external structure).

UNIT IV
Assessing geological hazards and risks, types of hazards earth quakes, volcanic eruptions, floods, subsidence, landslides, hazards of oceans and weather- preventive and precautionary measures. Environmental impacts of mining, surface blasting etc. Impact assessment of mining; dumping of ores; mine waste and fly ash

UNIT V
Impact assessment of degradation and contamination of surface water and groundwater quality due to industrialization and urbanization; organic and inorganic contamination of groundwater and its remedial measures; water logging problems. Soil profiles and soil quality degradation.

Course outcome:
The students will be able to understand the interaction of humans with the geological environment. It will lead to having basic knowledge related to occurrence, causes, impact and mitigation of natural hazards. The role of anthropogenic activities on natural environment will be discussed.

Suggested Readings:

1. Keller, E.A.:- Environmental Geology
2. Buyant, E.: -Natural Hazards
3. Valdiya, K.S.: -Environmental Geology- Indian Context
4. Patwarrdhan, A.M.: -The Dynamic Earth System
5. Bell, F.G.: -Geological Hazards
6. Smith, K.: -Environmental Hazards
7. Subramaniam, V.: -Textbook in Environmental Hazards
8. Tank, R.W.: -Focus on Environmental Hazards
9. Strahler and Strahler: -Environmental Geology

AGF-42 Engineering Geology and Groundwater

UNIT I

Behaviour of rock on application of stresses: Stress and its type; Strain and its type Application of Strain and stress curve; Mohr's Circle and Stress Transformation.

UNIT II

Tunnels and types; Stress conditions in tunnels; Site selection for tunnel excavation and support; Slope Stability and Site selection for the construction of roads in hilly terrains.

UNIT III

Dams and their types; Geotechnical problems associated with bridges and dams; Site selection for dam construction, construction materials.

UNIT IV

Hydrological cycle; Occurrence of Groundwater; Genetic classification of water; Darcy's law; Water-bearing characteristics of rocks; Types and characteristics of Aquifers.

UNIT V

Artificial recharging of aquifers; Techniques of Ground water exploration; Saline water intrusion; Types of wells.

Course outcome:

The scientific understanding of the geological parameters is important for construction of Tunnels, Dam and Highway. The course focuses on the role of geology for suitable construction of engineered structures for the society.

Water is a basic life supporting system. The rise in global population and the quest for better living standards has greatly stressed the water resources. The course content primarily focuses on groundwater. Thus this course aims to enable students to acquire knowledge about the occurrence, movement and exploration of the groundwater resources.

Suggested Readings:

1. D. P. Krynine and W. R. Judd. 1957. Principles of Engineering Geology and Geotechnics, CBS publishers and distributors pvt. Ltd.
2. Bhawani Singh and R. K. Goel. 1999. Rock Mass Classification: A Practical Approach in Civil Engineering, Elsevier Science
3. Davies, S.N. and De-West, R.J.N., 1966. Hydrogeology, John Wiley & Sons, New York.
4. Driscoll, F.G., 1988. Ground Water and Wells, UOP, Johnson, Div. St. Paul. Min. USA.
5. Fetter, C.W., 1984. Applied Hydrogeology, McGraw-Hill Book Co., New York.
6. Fitts, C.R., 2006. Groundwater Science, Academic Press.
7. Freeze, R.A. and Cherry, J.A., 1979. Groundwater, Englewood Cliffs, New Jersey: Prentice-Hall.
8. Karanth K.R., 1987. Groundwater: Assessment, Development and Management, Tata McGraw-Hill Pub. Co. Ltd.
9. Raghunath, H.M., 1987. Ground Water, Wiley Eastern Ltd., Calcutta.
10. Schward and Zhang, 2003. Fundamentals of Groundwater, John Willey and Sons.
11. Todd, D.K., 2004. Ground Water Hydrology, John Wiley & Sons, New York.

AGF-43 Climatology

UNIT I

Climatology, scope, aims and objects, Climate and weather, Structure of the atmosphere, troposphere, stratosphere, mesosphere, ionosphere, exosphere. Composition of the atmosphere. Atmospheric boundarylayers and, lapse rate. Insolation, Solar radiation, Heat Budget, Factors affecting distribution of insolation, latitudinal and seasonal variation of insolation,

UNIT II

Temperature of the atmosphere, distribution of temperature, inversion of temperature, Air pressure, distribution of air pressure, variation in air pressure, General circulation of the atmosphere, surface windsystem, wind belts, humidity, fog and clouds, cloud formation, types of precipitation.

UNIT III

Air masses, Monsoon, Jet streams, Coupled ocean-atmosphere system, El Nino Southern Oscillation(ENSO), Cyclones, and Anticyclones, Tropical meteorology: Trade wind inversion, ITCZ; Western disturbances; SW and NE monsoons. Weather elements like thunderstorms, tornadoes.

UNIT IV

Climatic and sea level changes on different time scales, General weather systems of India, Distribution of precipitation over India, Classification of climates, Koppen's and Thornthwaite's scheme of classification.

UNIT V

Climate change. Causes of Climate Change, Green House gases and effect, Pollution in the atmosphere, Arctic and Antarctic Indian Expeditions. Climate Change Natural/Anthropogenic, Impact of climate change in the society, Climate change in the earth history.

Course outcome:

The students will be made to understand the basic structure & composition of the atmosphere which is important for our survival. Climate change is one of most important parameters which is affecting the society and its development. The course will provide the basic understanding of the climate and climate change. We are all aware of the fact that the monsoon affects our agriculture and thus the agrarian economy of India. It is thus felt that the analysis and concept of monsoon should be known common man in general and the students in particular.

Suggested Readings:

1. Willett, S. D., 2006. Tectonics, Climate, and Landscape Evolution, Geological Society of America Publication.
2. Bradley, R.S., Paleoclimatology: Reconstructing Climates of the Quaternary, Academic. Press.
3. Lal, D.S.2003. Climatology. Sharda Pustak Bhawan
4. C. Donald Ahrens, 2001. Essentials of Meteorology: An Invitation to the Atmosphere. Publisher Brooks/Cole/Thomson Learning

AGP-45 Laboratory work and Viva –Voce

Laboratory exercises related to Well-logging and Techno-economics, Exploration, Drilling, Production and Reservoir Engineering, Indian Petroliferous Basins, Energy Resources and Geochemistry.

Every student shall be required to keep and maintain up-to-date record of practical work during the session, properly signed by the teachers concerned and submit it at the time of their Practical Examination.

Course Outcome:
It is the laboratory work relating to the different aspects of the subject covered in this semester. Additionally, the student may be asked to prepare a detailed project report on an allotted subject and would also be required to make a detailed power point presentation.

AG-46 Field Work/ Project Work / Industry visit/ Industrial Training/Dissertation

Practical Training Including Case Study, Tutorials and Report/ Dissertation Writing & Presentation

Course Outcome:
It is an important integral part of all geological studies, which includes field work, Industrial visit, Industrial training, dissertation etc. relating to the course work.

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