

INSTITUTE OF HYDROCARBON, ENERGY AND GEO-RESOURCES

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

1. Applicability:

These regulations shall apply to the M.Sc. in Applied Geology (with specialization in Petroleum Geosciences) programme for the session 2020-21 and onwards.

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.

2. Minimum Eligibility for admission:

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.

3. Programme Objectives:

Institute of Hydrocarbon, Energy and Geo-resources, at ONGC Centre of Advanced Studies, University of Lucknow offers M.Sc. in Applied Geology programme with objective of educating students for success as a geo-scientist in government sector, public sector, private sector, research institutes, or further pursuit of Doctoral studies. This programme is designed in a way so as to promote the study and research in Petroleum Geology and to help the students develop their career in oil industries.

4. Program Outcome:

The M.Sc. in Applied Geology (with specialization in Petroleum Geosciences) program in Institute of Hydrocarbon, Energy and Geo-Resources, ONGC Centre of Advanced Studies, University of Lucknow is designed with the objective of educating students for success as a geo-scientist in government sector, public sector, private sector, research institutes etc. The students are also tuned to qualify the NET or Gate Examinations so as to pursue the career in academics. 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.

5. Specific Programme 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 geosciences. 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. Geological excursion and research based activities are important component of Master's Programme in Applied Geology.

6. Course Structure:

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

<i>Course no.</i>	<i>Name of the course</i>	<i>Credits</i>	<i>Remarks</i>
SEMESTER I			
AGCC-101	Basics of Earth Sciences	4	Core Course
AGCC-102	Sedimentology	4	Core Course
AGCC-103	Stratigraphy	4	Core Course
AGCC-104	Mineralogy, Crystallography and Igneous Petrology	4	Core Course
AGCC-105	Practical: Laboratory Work	4	Core Course
AGVC-101	Environment and Natural Disaster	4	Value added course (Credited)
Semester Total		24	600
SEMESTER II			
AGCC-201	Structural Geology and Tectonics	4	Core Course
AGCC-202	Palaeontology	4	Core Course
AGCC-203	Metamorphic Petrology and Economic Geology	4	Core Course
AGCC-204	Petroleum Geology and Production	4	Core Course
AGCC-205	Introduction of Geophysics	4	Core Course
AGCC-206	Practical: Laboratory Work and Geological Excursion	4	Core Course
AGVNC-201	Instrumentation and Dating Techniques	0	Value added course (Non-Credited)
Semester Total		24	600
SEMESTER III			
AGCC-301	Sedimentary Basins	4	Core Course
AGCC-302	Exploration and Drilling	4	Core Course/MOOC
AGEL-301-A	Energy Resources and Geochemistry	4	Elective
AGEL-301-B	Engineering Geology and Groundwater		
AGEL-302 A	Practical: Laboratory Work and Geological Excursion	4	Elective
AGEL-302 B	Project Work		
AGIN-301	Internship	4	Internship
AGIER-301	Remote Sensing and its Application	4	Inter-departmental Course
Semester Total		24	600
SEMESTER IV			
AGCC-401	Well Logging	4	Core Course
AGEL-401	Sequence Stratigraphy	4	Elective
AGEL-402A	Indian Petroliferous Basins	4	Elective
AGEL-402 B	Environmental Geology		
AGMT-401	Master Thesis	8	Master Thesis
AGIRA-401	Climatology and Climate Change	4	Intra-departmental Course
Semester Total		24	
GRAND TOTAL		96	

5. Course Outline:

FIRST SEMESTER

AGCC-101 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:

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

AGCC-102 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 know 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:

Prothero, Donald R., 2013. Sedimentary Geology: An Introduction to Sedimentary Rocks and Stratigraphy. W. H. Freeman; Third edition

Reading, H.G., 2009. Sedimentary Environments: Processes, Facies and Stratigraphy. John Wiley & Sons.

Leeder, Mike, 2009. Sedimentology and Sedimentary Basins: from Turbulence to Tectonics. John Wiley & Sons.

Collinson, J.D. and Thompson, D.B., 1988. Sedimentary Structures, Unwin Hyman, London.

Leeder, M.R., 1982. Sedimentology: Process and Product. George Allen & Unwin, London, 344p.

Prothero and Schwab, 2004. Sedimentary Geology, Freeman

Miall, A.D., 1999. Principles of Sedimentary Basin Analysis 3rd edition, Springer Verlag, New York.

Nichols, G., 1999. Sedimentology and Stratigraphy, Blackwell publishing.

Sam Boggs, 1995. Principles of Sedimentology and Stratigraphy, Prentice Hall, New Jersey.

Tucker, M.E., 2006. Sedimentary Petrology. Blackwell Publishing.

AGCC-103 Stratigraphy

UNIT I

Principles of stratigraphy: Lithostratigraphic, Magnetostratigraphic, Chronostratigraphic and Biostratigraphic units; Stratigraphic correlation.

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. Boundary problems of stratigraphy.

Course Outcome:

The sequence of deposition of stratigraphic horizons over period of time since the time the earth came into being up to 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:

Doyle, P. and Bennett, M.R., 1996. Unlocking the Stratigraphic Record, John Willey.

Dunbar, C.O. and Rodgers, J., 1957. Principles of Stratigraphy. John Wiley & Sons.

Krishnan, M.S., 1982. Geology of India and Burma, C.B.S. Publishers, Delhi

Naqvi, S.M. 2005. Geology and Evolution of the Indian Plate: From Hadean to Holocene4 Ga to 4 Ka. Capital Pub., New Delhi.

Pascoe, E.H., 1968. A Manual of the Geology of India & Burma (Vols.IN), Govt. of India Press, Delhi.

Pomerol, C., 1982. The Cenozoic Era - Tertiary and Quaternary. Ellis Harwood Ltd., Halsted Press.

Schoch, R.M., 1989. Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York. 9.

Vaidyanathan, R. & Ramakrishnan, M., 2008. Geology of India, Geological Society of India.

AGCC-104 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; Plume magmatism and hot spots; Mantle metasomatism; Mantle heterogeneities; 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:

Paul F. Kerr, 2014. Optical Mineralogy. McGraw Hill Education (India) Pvt. Ltd.

John D. Winter, 2018. Principles of Igneous and Metamorphic Petrology. Pearson India Education Services Pvt. Ltd.

Dexter Perkins, 2016. Mineralogy. Pearson India Education Services Pvt. Ltd.

Hota, Rabindra Nath, 2017. Practical Approach to Crystallography and Mineralogy. CBS Publishers & Distributors Pvt. Ltd.

Ernest G. Ehlers and Harvey Blatt, 1999. Petrology: Igneous Sedimentary and Metamorphic. CBS Publishers & Distributors Pvt. Ltd.

Cornelis Klein and Anthony R. Philpotts. 2017. Earth Materials: Introduction to Mineralogy and Petrology. Cambridge University Press.

Cornelis Klein and Barbara Dutrow, 2007. The manual of Mineral Science, Wiley Publication

Anthony R. Philpotts and Ague, J.J. 2009. Principles of Igneous and Metamorphic Petrology. Cambridge.

Best, M.G. 2013. Igneous and Metamorphic Petrology. Wiley Blackwell.

Alexander R. McBirney, 2006 Igneous Petrology, III edition: Alexander R McBirney.

It includes the 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.

Course Outcome

It provides the students with the overall practical knowledge of the entire gamut of subjects studied in this 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.

AGVC-101 Value added Course (Credited) - Environment and Natural Disaster

UNIT I

Concepts of Environment, Components of Environment, Greenhouse gases and its impact on planet earth, Greenhouse effect.

UNIT II

Introduction to the Atmosphere, Composition and stratification of the atmosphere. Clouds, and Precipitation. Weather and its component.

UNIT III

Winds and Storms, Types of winds. Evolution of Cyclones and Anticyclones, Types of cyclones and anticyclones.

UNIT IV

Hazards and disaster, Types of disaster. Concepts of rivers and Fluvial hazards - flooding, channel migration, bank erosion and flash floods. Earthquakes, magnitude and intensity of earthquakes.

UNIT V

Tsunami, Landslide and volcanic hazards their causes and control. Pollution and their major causes. Mitigation and management of Natural Hazards.

Course Outcome

The main outcome of this course is to create awareness of both the natural disasters and their management techniques. And also, to familiarize the students with the foundations and the recent trends in environment and disaster management.

Suggested Readings

- Ahmad, A. (2010): Disaster Management: Through the New Millennium, Anmol Publications, New Delhi.29
Bryant Edwards (2005). Natural Hazards, Cambridge University Press, U.K.
Bureau of Indian Standards (2002). Indian Standards: Criteria for Earthquake Resistant Design of Structures, Part I, Fifth Revision.
Burton, I., Kates, R.W. and White, G.F. (1993). Environment as Hazard,2nd edition, Guilford Press, New York.
Central Water Commission (1989). Manual of Flood Forecasting, New Delhi.
Kapur, A (2005). Disasters in India: Studies of Grim Reality, Rawat Publications, Jaipur.
Kapur, A. (2010). Vulnerable India: A Geographical Study of Disasters, Sage Publications, New Delhi.
NDMA (2009): National policy on Disaster Management http://nidm.gov.in/PDF/policies/ndm_policy2009.pdf.
Bell, F.G., 1999. Geological Hazards, Routledge, London.
Bryant, E., 1985. Natural Hazards, Cambridge University Press.

SECOND SEMESTER

AGCC-201 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 its 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:

Fossen, H., 2016. Structural Geology. Cambridge University Press.

Davis, G.H. and Reynolds, S.J., 1996. Structural Geology of rocks and regions, John Wiley. and Sons.

Ghosh, S.K., 1993. Structural Geology: Fundamentals, and modern developments, Pergamon Press.

Leyson, P.R. and Lisle, R.J., 1996. Stereographic projection techniques in structural geology, Cambridge University Press.

Passier, C. and Trouw, R.A.J., 2005. Microtectonics. Springer, Berlin.

Pollard, D.D. and Fletcher, R.C., 2005. Fundamentals of structural geology, Cambridge University Press.

Ramsay, J.G. and Huber, M.I., 1983. Techniques of Modern Structural Geology: vol.I & II. Academic Press.

Ramsay, J.G., 1967. Folding and Fracturing of Rocks, McGraw-Hill Book Company, New York.

Twiss, R.J. and Moores, E.M., 2007. Structural Geology. Freeman.

Van der Pluijm, B.A. and Marshak, S., 2004. Earth structure: an introduction to structural Geology.

AGCC-202 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 its 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:

- Moore, Raymond C., Lalicker, Cecil G. and Fischer, Alfred G., 1952. Invertebrate Fossils. McGraw-Hill Book Co., Inc. USA.
- Shrock, Robert, R. and Twenhofel, William H. 2005. Principles of Invertebrate Paleontology. McGraw-Hill Book Co., Inc. USA.
- Cowen, R., 2000. History of Life, Blackwell Science.
- E. N. K. Clarkson (2013). Invertebrate palaeontology and Evolution, Blackwell Science
- Black, R.M., 1989. The Elements of Palaeontology, Cambridge University Press
- Benton, Michael, 2005. Vertebrate Palaeontology, Blackwell Publishing
- Jain, Sreepat, 2017. Fundamentals of Invertebrate Palaeontology: Macrofossils, Springer India
- Saraswati, Pratul Kumar and Srinivasan, M.S., 2016. Micropaleontology: Principles and Applications, Springer International Publishing Switzerland.
- Michael Benton, David A. T. Harper, 2009. Introduction to Paleobiology and the Fossil Record, Wiley-Blackwell.
- Colbert, E.H. and Minkoff, Eli C., 2001. Evolution of vertebrates. Wiley Liss

AGCC-203 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; Concepts of mineral exploration; Ore-bearing fluids: their origin and migration; Magmatic ore deposits, hydrothermal ore deposits, Ore deposits formed by chemical and sedimentary processes; Metamorphic ore deposits; Concepts of surface and subsurface mining; Strategic, Critical and Essential minerals; Distribution of various types of ore deposits and Industrial minerals in India; National Mineral Policy and Mineral Concession Rules.

Course Outcome:

This course aims to enable the students to have broader perspective of metamorphic processes and metamorphic rocks and provide theoretical basis for interpreting the geodynamic processes. 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:

- Best, M.G., 2013. Igneous and Metamorphic Petrology. Wiley Blackwell.
- Barker, A.J., 2004, Introduction to Metamorphic Textures and Microstructures, Routledge.
- Bucher, K. and Grapes, R., 2011, Petrogenesis of Metamorphic Rocks, Springer.
- Kretz, R., 1994. Metamorphic Crystallization, Wiley-Blackwell.
- Mason, R., 1990. Petrology of the Metamorphic Rocks, Unwin Hyman Ltd.
- Philpotts, A. and Ague, J., 2009. Principles of Igneous and Metamorphic Petrology, Cambridge University Press.
- Spear, F.S., 1993. Metamorphic Phase Equilibria and Pressure–Temperature–Time Paths, Mineralogical Society of America.
- Spry, A., 1969. Metamorphic Textures, Pergamon Press.
- Vernon, R.H. and Clarke, G.L., 2008. Principles of Metamorphic Petrology, Cambridge University Press.
- Walther, J.V. and Wood, B.J., 1986. Fluid-Rock Interactions during Metamorphism, (Advances in Physical Geochemistry Book 5), Springer
- Winter, J.D., 2009. Principles of Igneous and Metamorphic Petrology, Pearson.
- Moon, C.J., Michael, K.G. Whateley and Anthony M. Evans. (Editors), 2012. Introduction to Mineral Exploration. Blackwell Publishing. Wiley India Pvt. Ltd.
- Walter L. Pohl, 2016. Economic Geology Principles and Practice. Wiley India Pvt. Ltd.
- Prasad, Umeshwar, 2018. Economic Geology: Economic Mineral Deposit. CBS Publishers & Distributors Pvt. Ltd.

AGCC-204 Petroleum Geology and Production**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; Gas Hydrates,

UNIT V

New Resources of Hydrocarbons: Coal Bed Methane, Shale Gas. Oil production methods; Concept of Enhanced Oil Recovery; Techniques of Enhanced Oil Recovery (EOR); Planning of Enhanced Oil Recovery.

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:

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

AGCC-205 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:

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

AGCC-206 Laboratory work and Geological Excursion

It includes the Laboratory exercises related to Structural Geology, Palaeontology, Metamorphic Petrology, Economic Geology and Petroleum Geology. Excursion would be conducted by faculty members and if required the research scholars may accompany the faculty members. The marks would be given by faculty member/s on the basis of activity and performance of student in during field work, Field diary/field report and Viva-voce.

Course Outcome:

It is the practical understanding the practical aspects of the courses that is studied in theory in this 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. Geology is a field-based subject. Field sites are ideal places to observe different types of landforms, minerals, rocks, and geological structures like faults, folds, joints and unconformities. Geological excursion will motivate the students learning geology through geomorphic features like mountain ranges, peaks, slopes, valleys, plains, etc. which will improve their self-explaining potential significantly and at the same time, their curiosity towards systematic observation of topographic maps, and their corresponding geomorphic features, rock types, mineralogical composition, and geological structures will also be increased notably to make a proper geological interpretation.

AGVNC-201 Value added Course – Instrumentation and Dating techniques**UNIT I**

Physical characteristics of the sediments and instruments to measure it.

UNIT II

Physical characteristics of the water and instruments to measure it.

UNIT III

Chemical characteristics of the sediments and instruments to measure it.

UNIT IV

Chemical characteristics of the water and instruments to measure it.

UNIT V

Dating techniques of organic and non-organic sediments.

Course Outcome: It emphasises on various physical as well as chemical characteristics of sediments and water and various instrumentation techniques used to measure these characteristics. It also provides the basic understanding of the techniques used for dating the organic and non-organic sediments.

Suggested Readings:

Walker, Mike (2005). Quaternary Dating Methods. Wiley.

Bowen, D.Q. (1977). Quaternary Geology: A Stratigraphic Framework for Multidisciplinary Work. Pergamon Publisher.

SEMESTER III

AGCC-301 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:

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

AGCC-302 Exploration and Drilling

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

Safety aspects, types of safety instrumentations, their functions and utility.

Course Outcome:

The course content provides 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:

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

AGEL-301-A 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

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 and 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; 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 are also imparted to provide a complete knowledge base to the students.

Suggested Readings:

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

AGEL-301 B--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:

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

GEL-302 A Practical: Laboratory Work and Geological Excursion

It includes the Laboratory exercises related to theory papers in this semester. Excursion would be conducted by faculty members and if required the research scholars may accompany the faculty members. The marks would be given by faculty member/s on the basis of activity and performance of student in during field work, Field diary/field report and Viva-voce.

Course Outcome:

It is the practical understanding the practical aspects of the courses that is studied in theory in this semester. Problems related to exploration, drilling and sedimentary basins are all taken up during the practical classes. Geology is a field-based subject. Field sites are ideal places to observe different types of landforms, minerals, rocks, and geological structures like faults, folds, joints and unconformities. Geological excursion will motivate the students learning geology through geomorphic features like mountain ranges, peaks, slopes, valleys, plains, etc. which will improve their self-explaining potential significantly and at the same time, their curiosity towards systematic observation of topographic maps, and their corresponding geomorphic features, rock types, mineralogical composition, and geological structures will also be increased notably to make a proper geological interpretation.

AGEL-302 B 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: In this course, students will be assigned a topic of their choice to prepare an elaborative report on the various aspects of the topic chosen. This will enable the students to develop a capability to work on various geological problems independently and collect deeper knowledge of their subject.

AGIN-301 Internship

In Internship, students will work in any industry, research laboratory or academic institution to learn the various theoretical, practical and field aspects of the subject. The students need to prepare a report and give a presentation on the topic they have worked for during the internship.

Course outcome: This course will enable the students to develop skills and field or industry-based knowledge of their subject which will ultimately add to enhance their career aspects.

AGIER-301 - Inter-department 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.

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 geosciences. The course content also highlights the introduction of the new techniques of GIS and GPS.

Suggested Readings:

T.M. Lillesand and P.W. Kiefer (2016). Remote Sensing and Image Presentation. Wiley.

R.P. Gupta (2016). Remote Sensing Geology. Springer.

F.F. Sabins (2007). Remote Sensing, Principal and Interpretation. Waveland Pr. Inc.

P.R. Wolf and B.A. Dewitt (2004). Elements of Photogrammetry with applications in GIS.

Semester IV

AGCC-401 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, Methods and Apparatus used in 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:

Serra, L. and Serra, O., 2004. Well Logging and Geology. Publisher: Editions Technips.

Asquith, G. and Gibson, C., 1982. Basic Well Log Analysis for Geologists. Publisher: Amer Assn of Petroleum Geologists.

Bateman, R.M., 1986. Open Hole Log Analysis and Formation Evaluation. Publisher: Springer.

Ellis, Darwin V. and Singer, Julian M., 2007. Well Logging for Earth Scientists. Publisher: Springer.

Seera, O., 2008. Well Logging Handbook. Publisher: Editions Technips.

Bassiouni, Zaki, 2016. Theory, measurement, and interpretation of well logs. Publisher: Society of Petroleum Engineers, Inc.

Liu, C. Richard., 2017. Theory of Electromagnetic Well Logging. Publisher: Elsevier.

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)

Jonathan Evenick, C., 2008. Introduction to Well Logs and Subsurface Maps. Publisher: PennWell Corp.

AGEL-401 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

Sequence boundaries, types of sequence boundaries, Major surfaces formed during transgression and regression, Modern Sequence Stratigraphy.

UNIT V

Low System Tract, High System Tract, Transgressive System Tract; Maximum Flooding Surfaces.

Course Outcome:

The understanding of the sequence of stratigraphic successions is important for 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 are also taught so as to provide a vivid picture of the sequence stratigraphy in different set-ups.

Suggested Readings:

Catuneanu, O., 2006. Principles of Sequence Stratigraphy. Elsevier Science
Emery, D. and Myers, K. (Editors), 1996. Sequence Stratigraphy. Wiley Online Library.
Sam Boggs Jr., 2010. Principles of Sedimentology and Stratigraphy. Publisher: Pearson.
Miall, A.D., 2010. The Geology of Stratigraphic Sequences. Publisher: Springer.
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).
Miall, A.D., 2016. Stratigraphy: A Modern Synthesis. Springer.
Leckie, D.A. and James, D.P. 1988. Sequences, Stratigraphy, Sedimentology: Surface and Outcrop. Publisher: Canadian Society of Petroleum Geologists.

AGEL-402-A- Indian Petroliferous Basins**UNIT I**

Basics of Petroliferous Basins; History of petroleum geology in India; Petroleum products. Types of sedimentary basin in India.

UNIT II

Assam Basin: basic introduction, reservoir rock, structural trap, stratigraphy and oil wells. Cambay Basin: basic introduction, reservoir rock, structural trap, stratigraphy and oil wells.

UNIT III

Cauvery Basin: basic introduction, reservoir rock, structural trap, stratigraphy and oil wells. Mumbai Offshore Basin: basic introduction, reservoir rock, structural trap, stratigraphy and oil wells.

UNIT IV

Case Study of Indian Sedimentary Basins: Mahanadi Basin, Tripura Basin. Rajasthan Basin, Krishna- Godavari Basin.

UNIT V

Prospects of new petroleum basins in India. Alternative energy resources: Renewable energy.

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:

Bhandari, L.L. (Editor), 1983. Petroliferous Basins of India. KDM Institute of Petroleum Exploration Himachal Times Group, 1983.

Zutshi, P. L. and Panwar, M.S. , 1997. Geology of petroliferous basins of India. Publisher KDM Institute of Petroleum Exploration

AGEL-402-B--Environmental Geology

UNIT I

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

UNIT II

Chemistry of greenhouse gases, emission of CO₂, consequences of greenhouse 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 have a 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:

Keller, E.A.: Environmental Geology
Buyant, E.: -Natural Hazards
Valdiya, K.S.: -Environmental Geology- Indian Context
Patwardhan, A.M.: -The Dynamic Earth System
Bell, F.G.: -Geological Hazards
Smith, K.: -Environmental Hazards
Subramaniam, V.: -Textbook in Environmental Hazards
Tank, R.W.: -Focus on Environmental Hazards
Strahler and Strahler: -Environmental Geology
Truk and Truk: -Environmental Geology

AGMT-401 Master Thesis

During the IV Semester, the students shall undertake a Dissertation on a topic of Geology. The topic of Dissertation shall be assigned to the students in the beginning of the Third Semester. Based on the overall merit of the student during previous two Semesters and Faculty available in the Department, they would be allotted a project and attached to a Faculty Member in the Department who would act as their Dissertation Supervisor.

The students shall remain in contact with their Supervisor, for day-to-day progress of the work done by them. During the course of completion of the Dissertation work, the student will be required to complete various assignments given to them by their respective Supervisor, for the purpose of evaluation.

The students will be required to submit the Dissertation by the date specified to them in the Fourth Semester. This will be followed by a Presentation before panel of Examiner(s) for the purpose of evaluation.

The Dissertation shall be evaluated by supervisor on the basis of submitted Dissertation Work (Thesis), Multimedia Presentation followed by Viva-voce Examination evaluated by panel of examiners.

Course outcome: Upon successful completion, students will have the knowledge and skills to 1. plan, and engage in, an independent and sustained critical investigation and evaluation of a chosen research topic relevant to environment and society 2. systematically identify relevant theory and concepts, relate these to appropriate methodologies and evidence, apply appropriate techniques and draw appropriate conclusions; 3. engage in systematic discovery and critical review of appropriate and relevant information sources; 4. appropriately apply qualitative and/or quantitative evaluation processes to original data; 5. understand and apply ethical standards of conduct in the collection and evaluation of data and other resources; 6. communicate research concepts and contexts clearly and effectively both in writing and orally.

AGIRA-401- Intradepartmental Course - Climatology and Climate Change

UNIT I

Climatology, scope, aims and objects, Climate and weather, Structure of the atmosphere, troposphere, stratosphere, mesosphere, ionosphere, exosphere. Composition of the atmosphere. Atmospheric boundary layers and, lapse rate.

UNIT II

Insolation, Solar radiation, Heat Budget, Factors affecting distribution of insolation, latitudinal and seasonal variation of insolation, 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 wind system, wind belts, humidity, fog and clouds, cloud formation, types of precipitation.

UNIT III

Air masses, Monsoon, Jet streams, El Nino Southern Oscillation (ENSO), Cyclones, and Anti-cyclones, Tropical meteorology: Trade winds, ITCZ; Western disturbances; SW and NE monsoons.

UNIT IV

Climatic and sea level changes on different time scales, General weather systems of India, Distribution of precipitation over India, Classification of climate.

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, 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 to the common man in general and the students in particular.

Suggested Readings:

Willett, S. D., 2006. Tectonics, Climate, and Landscape Evolution, Geological Society of America Publication.

Bradley, R.S., Paleoclimatology: Reconstructing Climates of the Quaternary, Academic. Press.

Lal, D.S.2003. Climatology. Sharda Pustak Bhawan

C. Donald Ahrens, 2001. Essentials of Meteorology: An Invitation to the Atmosphere. Brooks/Cole/Thomson Learning
