SOLAPUR UNIVERSITY, SOLAPUR

REVISED SYLLABUS - M.Sc. I Applied Geology

To be implemented from year 2011-2012

M.Sc. SEMESTER - I and II

SCHOOL OF EARTH SCIENCES,

SOLAPUR UNIVERSITY, SOLAPUR.

SYLLABUS OT THE M. Sc . APPLIED GEOLOGY

STRUCTURE OF THE COURSE

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REVISED SYLLABUS - M.Sc. I Applied Geology

To be implemented from year 2011-2012

M.Sc. SEMESTER - I and II

SCHOOL OF EARTH SCIENCES, DEPARTMENT OF ENVIRONMENTAL SCIENCE
SOLAPUR UNIVERSITY, SOLAPUR.
SYLLABUS OT THE M. Sc ENVIRONMENTAL SCIENCE
STRUCTURE OF THE COURSE

SEMESTER I

COURSE CODE	SUBJECT	Hours /week	EXTERNAL MARKS	INTERNAL MARKS
AGT 101	MINERALOGY AND OPTICS	4	70	30
AGT 102	IGNEOUS AND METAMORPHIC PETROLOGY	4	70	30
AGT 103	SEDIMENTOLOGY AND PALAEONTOLOGY	4	70	30
AGT 104	GEOMORPHOLOGY AND MORPHOTECTONICS	4	70	30
AGP 105	PRACTICAL RELATED TO AGT 101 & EST 102	6	70	30
AGP 106	PRACTICAL RELATED TO AGT 103 & EST 104	6	70	30

SEMESTER II

AGT 201	ECONOMIC GEOLOGY	4	70	30
AGT 202	INDIAN STRATIGRAPHY	4	70	30
AGT 203	HYDROGEOLOGY		70	30
AGT 204	GEOCHEMISTRY	4	70	30
AGP 205	PRACTICAL RELATED TO AGT 201 & AGT 202	6	70	30
AGP 206	PRACTICAL RELATED TO AGT 203 & AGT 204	6	70	30

SEMESTER III

AGT 301	STRUCTURAL GEOLOGY AND GEOTECTONICS	4	70	30
AGT 302	MINERAL EXPLORATION	4 4	70	30
AGT 303	ENGINEERING GEOLOGY AND MINING GEOLOGY	4	70	30
AGT 304	NATURAL RESOURCE AND WATERSHED MANAGEMENT	4	70	30
AGP 305	PRACTICAL RELATED TO AGT 301 & AGT 302	6	70	30
AGP 306	PRACTICAL RELATED TO AGT 303 & AGT 304	6	70	30

SEMESTER IV

AGT 401	ENVIRONMENTAL GEOLOGY AND DISASTER MANAGEMENT	4 4	70	30
AGT 402	ENERGY RESOURCES	4	70	30
AGT 403	REMOTE SENSING AND GIS	4	70	30
AGT 404	DISSERTATION	4	70	30
AGP 405	PRACTICAL RELATED TO AGT 401 & AGT 402	6	70	30
AGP 406	PRACTICAL RELATED TO AGT 403 & AGT 404	6	70	30

TOTAL DURATION OF THE COURSE: 2 YEARS

Each Semester will have 1 credits (25 Marks) for- Field training for long tour / In-plant Training,/ Industrial visits or Nature visits /Field work, data acquisition related to dissertations

M.Sc. I SEMESTER I

AGT101 : MINERALOGY AND OPTICS

OPTICS **(18 Marks)**

Unit I Concept of light under microscope. Uniaxial and Biaxial Ellipsoids, Interference figure of uniaxial and biaxial minerals, Determination of optic sign, Flash figure, Refractive Index. Birefregence and various 2V determination methods, Pleochroism.

Unit II Bravais Lattice and Point group, 32 classes of symmetry, laws of twinning and types of twin.

MINERALOGY **(52 Marks)**

Unit I Crystal structure, chemistry, diagnostic properties and stability fields (P&T) of common rock forming mineral groups such as

1) Olivine,	2) Pyroxene,	3) Amphibole,
4) Micas,	5) Feldspar,	6) Felspathoids,
7) Zeolites	8) clay minerals,	9) Alumino silicates,
10) Garnet,	11) Epidote,	12) Tourmaline etc.

Unit II Sulphides and others: Base metals, Spinel, Sn-W-Mo, Carbonates and phosphates And gem minerals.

INTERNAL EVALUATION **(30 Marks)**
(Seminar + Term paper + Test)

REFERENCE BOOKS

1. An introduction to the rock forming minerals by Deer, Howie and Zutsman.
2. Rock forming minerals by Deer, Howie and Zutsman. (Vol. 1-5)
3. A textbook of mineralogy by Dana.
4. Elements of Mineralogy by Berry Mason.
5. Principles of Geochemistry by Brian Mason, C.B. Moore.
6. Optical mineralogy by P.F. Keer.
7. Optical Crystallography by E.E. Wahlstrom.
8. Optical mineralogy by Philips and Dana T. Griffen.
9. A practical introduction to optical mineralogy Gribble and Hall.
10. An introduction to crystallography by Phillips.
11. Minerals and rocks: exercise in crystallography, mineralogy and hand specimen by Corneis Klein.

AGT102 IGNEOUS AND METAMORPHIC PETROLOGY

IGNEOUS PETROLOGY (50 Marks)

- Magma: Nature, cooling behavior, properties and chemistry, volatiles in silicate melts.
- Study of phase systems under equilibrium conditions, silica-Lucite, forsterite-silica, diopside-albite-anorthite, orthoclase-albite, Experimental results of these systems and their application in petrology.
- IUGS classification of igneous rocks.
- Rock association, field occurrences, mineralogy, texture, chemistry and petrogenesis of the following with suitable Indian examples: Alkali Olivine Basalts, Tholeiitic Basalts-Quartz Diabase, Syenites, Nephelene Syenites, Lamprophyres, carbonatites, peridotites, serpentinites, anorthosites, granites, migmatites and rapakaivi granite, formation of perthites, spilites and keratophyres, kimberlites.
- Magmatism related with tectonism.

TEXT BOOKS

1) Igneous and Metamorphic petrology by F.J. Turner & Verhoogen.
2) Igneous petrology by M.K. Bose.
3) Igneous Petrology by Carmichel, Turner and Verhoogen.
4) Igneous and Metamorphic petrology by Best.
5) Evolution of Igneous rocks by Brown.

METAMORPHIC PETROLOGY (50 Marks)

- Introduction to metamorphic and metamorphic processes.
- Basic characteristics of metamorphic reactions: Solid-Solid reaction, Dehydration reaction, Decarbonation reaction and Oxidation-reduction reactions and their application to geothermobarometry.
- Diagrammatic representation of mineral reactions and mineral paragenesis : ACF, AKF, AFM, ActivitActivity diagrams, Schreinemakers rules and Petrogenetic grid.
- Facies classification and systematic description of regional and thermal metamorphism of pelitic, basic, ultrabasic and inpure calcareous rocks.
- Metamorphism, ultrametamorphism and anatexis, metamorphic differentiation and retrograde metamorphism.
- Metamorphism and Plate tectonics.

REFERENCE BOOKS

1) Metamorphism and metamorphic belts by Miyashiro A.
2) Metamorphic petrology by Turner F.J.
3) Metamorphic petrology by Turner and Verhoogen.
4) Igneous and metamorphic petrology by Turner and Verhoogen.Metamorphic petrology by Winkler.

INTERNAL EVALUATION (30 Marks)
(Seminar + Term paper + Test)

AGT103 SEDIMENTOLOGY AND PALAEONTOLOGY

SEDIMENTOLOGY (52 Marks)

- Introduction and principles of sedimentology.
- Sedimentary processes: Weathering- Mechanical, chemical, biological, sediment transport mechanism, deposition by fluids, simple fluid flow concepts- Reynolds no. and Froude no.
- Sedimentary textures: Textural elements of clastic and non clastic rocks, concept of size and shape, shape aspects-sphericity, roundness, form, surface textures, fractals, fabric, their measurement, statistical treatment and interpretation.
- Sedimentary structures: Classification of sedimentary structures – syndepositional and post depositional; their genesis and significance, principles and statistical treatment of palaeocurrent analysis.
- Application of textures and structures in sediment dispersal and basin analysis studies.
- Sedimetary environments: Classification of environments: continental, marine, transitional; their physical and chemical parameters, lithology and lithological associations, structures in alluvial, fluvial, deltaic, lacustrine, coastal, shallow marine, deep marine, glacial and Aeolian environments, basin classification in reaction to plate tectonic setting.
- Sedimentary rocks : Classification, principles, extrabasinal and interbasinal rocks, clastic and non clastic, sandstone classification,, light and heavy minerals, tectonic settings; Limestone classification, mineralogy, environment of deposition, dolomitisation and dedolomitisation, evaporates, phosphorites, chert and Fe-Mn rich rocks- genesis and environment of deposition.
- Lithification and diagenesis : Principles, defination, major stages in lithification and diagenesis of clastic and chemical rocks, with reference to sandstone and limestone.
- Sedimentation and tectonics: Tectonic control of sedimentation, diastrophic cycle, sediment cycle, plate tectonics and types and evolution of basins.

PALAEONTOLOGY **(18 marks)**

- Concept of Organic Evolution and fossil record.
- Evolution of : Devonian fishes, Mesozoic reptiles, siwalik mammals.
- Evolution of man.
- Study of Gondwana and Intertrappean flora.
- Micropalaeontology: Introduction, morphology, classification and stratigraphic record of foraminifera and their application.
- Significance of fossils in mineral exploration, stratigraphy and palaeogeography.

REFERENCE BOOKS

- Invertebrate palaeontology and evolution (2^{nd} ed.) By Clarkson E.N.K.
- Elements of Palaeontology by Babin C.
- Principles of Invertebrate Paleontology by Shock & Twenhofel.
- Paleontology of Vertebrates by Jean Chaline.
- Macropaleontology by Bignot.
- Paleontology Invertebrate by Wood .H

INTERNAL EVALUATION **(30 Marks)**

(Seminar + Term paper + Test)

AGT104 GEOMORPHOLOGY AND MORPHOTECTONICS (70 marks)

- Introduction : Fundamental concepts, uniformitarianism,
- Morphologic Evolutionary systems –cycle of erosion, concepts of Davis, Peenck, King. Geomorphic processes, structure stages.
- Depositional and erosional forms of - fluvial , Aeolian , marine. Glacial and Karst
- Coastal Geomorphology: sea level waves and currents, beach process and shorelines changes, classification of Coasts, Erosional and depositional forms.
- Climates and Landforms, humid, sub humid, arid, semiarid, nature of weathering.
- Scale of Geomorphic features and structural and tectonic landforms, fault scraps, cuesta and Hogback, Horst and Graben , structural domes.
- Drainage patterns , Rivers and tectonics, structural controls of drainage patterns,
- Effects of faulting.
- Tectonics of the Oceans : Tectonics and coastal classification , the origin of Ocean
- water and its implications.
- Lineament analysis. Neotectonism

INTERNAL EVALUATION (30 Marks)
(Seminar + Term paper + Test)

REFERENCE BOOKS

- Fundamentals of Geomorphology R.J. Rice
- Geomorphology be Richard J. Chorley, Stanley A. Schumm, David E.Sugden.
- Principles of Geomorphology by Willam D. Thornbury.
- Geomorphology by Majeed Husain.
- Indian Geomorphology by H.S. Sharma
- Experimental fluvial Geomorphology by Stanley A. Schumm, M. Paull Mosaley, William E. Weaver.
- Geomorphology and Remote Sensing in Environmental management by S.Singh
- The Evolving Continents by Windley.
- The Geology of continental Margins by Burke and Drake.
- The Breakup of Pangaea by R.S. Dietz and J. C. Holden.

PRACTICAL COURSE (MINERALOGY & OPTICS + IGNEOUS AND METAMORPHIC PETROLOGY)
(70 MARKS)

MINEROLOGY:-

- Sample preparation and obtaining XRD pattern.
- Indexing an XRD pattern. Calculation of 2 Ø and d spacing values.
- Calculation of mineral formula of the following;
  a) Olivine, b) Pyroxene, c) Amphibole, d) Garnet.
- Determination of anorthite content of plagioclase by optical properties.
- Megascopic and Microscopic identificcation of major rock forming minerals with emphasis on distinguishing features.

OPTICS:-

- Study of optic figures, optic axis, optic sign and flash figures of uniaxial and biaxial minerals.
- Determination of refractive index of uniaxial and biaxial minerals using various minerals.
- Determination of birefringence with the help of Michael Levy chart, quartz wedge and by using berek compensator.
- Determination of 2V by 4 axes universal stage.
- Scheme of Pleochroism.

IGNEOUS PETROLOGY:-

- Study of the mineralogy and textures of igneous rocks in thin sections.
- Calculation of CIPW norms and Niggli calculations for all types of saturated and unsaturated rocks.
- Megascopic and microscopic study of representative rocks.
- Quantitative mineralogical studies on thin section and rock classification.
- Use of computer programming in petrological studies.

METAMORPHIC PETROLOGY:-

- Study of representative metamorphic rocks megascopically and microscopically.
- Study of mineralogy and structures of metamorphic rocks in thin sections, paragenetic (Chronological) interpretations.
- Model analysis and calculations of ACF, AFM, AKF diagrams.
- Geothemobarometric calculations.

INTERNAL EVALUATION **(30 Marks)**
(Viva-voce + Journal + Data evaluation)

PRACTICAL COURSE AGP106 (SEDIMENTOLOGY AND PALAEONTOLOGY + GEOMORPHOLOGY AND MORPHOTECTONICS) (70 MARKS)

SEDIMENTOLOGY AND PALAEONTOLOGY

SEDIMENTALOGY:-

- Megascopic and Microscopic characters of Clastic rocks, Limestone and heavy minerals.
- Study of Sedimentary structures and their attributes, study of sedimentary textures-size analysis by sieving and other techniques.
- Determination of sphericity and roundness of grains, graphical presentation of data and determination of statistical parameters; insoluble residue analysis and preparation of acetate peels of limestone.

PALEAONTOLOGY

- Identification and study of Invertebrate fossils, illustration functional morphology and classification.
- Identification of Micro-fossils- foraminifera and ostracoda.
- Identification of plant fossils- Gondwana and intertrappean.
- Sample preparation in micropalaeontological studies

GEOMORPHOLOGY AND MORPHOTECTONICS

- Drainage basin and morphometry.
- Basin demarcation
- Ordering of streams – Strahler's and Horton methods
- Relief and slope analysis – profiles and maps.
- Identification of landforms on toposheets (aerial photographs and satellite imageries)
- Soils : textural characteristics, study of representative soil profiles.
- Morphometric analysis: bifurcation ratio, Drainage density, stream frequency, constant of channel maintenance.

INTERNAL EVALUATION (30 Marks)
(Viva-voce + Journal + Data evaluation)

EACH SEMESTER WILL HAVE 1 CREDIT (25 MARKS) FOR – FIELD TRAINING FOR LONG TOUR/IN PLANT TRAINING/INDUSTRIAL VISIT OR RECONNAISSANCE FIELD WORK DATA ACQUISITION RELATED TO DISSERTATION.

SEMESTER II

AGT201 ECONOMIC GEOLOGY

(70 Marks)

- Ore bearing fluids: Magma & Magmatic fluids, hydrothermal fluids, Meteotric waters, sea & connate water, metamorphic fluids, thermal springs & mine waters.
- Deposition of Ores: Magmatic segregation deposits, carbonatite deposits, hydrothermal deposits.
- Processes of formation of mineral deposits: magmatic concentration, metamorphism, contact metasomatism, hydrothermal, submarine exhalatives, volcanogenic deposits, residual & mechanical concentration, oxidation & supergene enrichment.
- Textural features of ores & their significance: Classification, textures of primary & secondary origin, textures developed due to deformation.
- Wall rock alteration, paragenetic sequence & zoning, fluid inclusion geothermocryometry & their applications.
- Mineral economics: Principles and concepts of mineral economics, India's status as regards to essential, critical and strategic mineral deposits, national mineral policy, metallogenic epochs & provinces of India.
- Mineralisation associated with convergent and divergent plate boundaries.
- Overview of mineral deposits viz : Iron, manganese, chromium, basemetals, precious metals, Industrial and refractory minerals with special reference to distribution in India. Their geology, stratigraphy & depositional environments.
- Mineral processing technology scope: of mineral processing its efficiency, ore handling, gravity concentration method, magnetic separation heavy, mineral separation, froth flotation method.

INTERNAL EVALUATION **(30 Marks)**

(Seminar + Term paper + Test)

Sr. No.	Author	Title	Publication
1.	M.L. Jensen & A.M. Batman	Economic mineral deposits	John Wiley & Sons
2.	J.M. Gulbert & C.F. Park (JR)	The Geology of Ore deposits	SWH Freeman & Co.
3.	B.A. Wills	Mineral processing technology	Peragamon Press
4.	F.J. Sawkins	Metal deposit in relation to plate tectonics	Springer – Verlag Press
5.	Evans	Ore deposits	--
6.	Asoke Moodherjee	Ore Genesis: A Holistic Approach	Allied Publishers Ltd.
7.	J.R. Craig & D.T. Vaughan	Ore Petrography & Microscopy	John Wiley & Sons
8.	R.K. Sinha	Mineral Economics	--
9.	R.K. Sinha & Krishnaswamy	Mineral Resources of India	Oxford & IBH Publishing Co. Pvt. Ltd.

AGT202 INDIAN STRATIGRAPHY (70 marks)

Precambrian Stratigraphy of India: -

The Archaean:

- Precambrian Stratigraphy of peninsular India.
- Classification, Structure and tectonics of Archaean Provinces of Peninsular India.
- Archaean orogeny in Indian cratons.
- Archaeans of the Extra-Peninsular region.

The Proterozoic

- Archaean - Proterozoic boundary problem
- Stratigraphy, classification and evolution of the following Proterozoic basins of peninsular India.
  - Cuddapah Basin
  - Vindhyan Basin
  - Delhi Super group
  - Pranhita - Godavari Basin
  - Indravati Basin
  - Bhima - Kaladgi Basin

Phanerozoic Stratigraphy of India:

- Palaeozoic History:
  - Precambrian - Cambrian boundary
  - Tectonism and life during palaeozoic time of India.
  - Marine Palaeozoic formations of Extra peninsular India.
- Mesozoic and Cenozoic History of India

INTERNAL EVALUATION (30 Marks)
(Seminar + Term paper + Test)

Reference Books:

1. Historical Geology and Stratigraphy of India by Ravindrakumar
2. Geology of India & Burma by D.N. Wadia
3. A manual of Geology of India and Burma by Pascoe volume 1,2,3,4
1. Geological Society of India Memoirs.
2. GSI record and Memoir volume.

AGT 203 HYDROGEOLOGY (70 Marks)

Defination of Hydrogeology.
Introduction, Hydrologic cycle, precipitation causes and types. Computation of average precipitation, Evapotranspiration, Infiltration, Run off : factors affecting them.
Darcy's Law and its range of validity, steady and unsteady flow.
Groundwater movement and tracer technique.
Occurrence of groundwater and hydrological properties of water bearing materials. Porosity and permeability, specific yield, specific retention, transmissivity, storage coefficient and their definition and methods of determination, hydraulic conductivity, hydrographs, water table contours map, hydrostratigraphic units, hydrology of arid and wet land.
Well hydraulics. Determination of aquifer characteristics from pumping tests.
Groundwater levels and fluctuation.
Fresh and salt water relationship in coastal areas, Ghyben-Herzbeg principle and its modification, prevention and control sea-water intrusion.
Groundwater Provinces of India.
Introduction to various methods of prospecting and exploration of groundwater. Consumptive and Conjuctive use of surface and groundwater.
Groundwater inventory, basic ideas of groundwater development and management, artificial recharge and water logging, Problems of over exploitation, Groundwater
Legislation, Assessment of quality and geochemistry of groundwater.
Computer application in hydrogeological studies.

INTERNAL EVALUATION (30 Marks)
(Seminar + Term paper + Test)

Reference Books :-

Todd, D.K., 1980: Groundwater. John Wiley.
Davies, S.N. & Dewiest, R.J.M. 1966: Hydrogeology. John Wiley.
Freeze, R.A. & Cherry, J.A., Groundwater. Prentice Hall.
Fetter,C.W. 1990: Applied Hydrogeology, Merill publishing.
Raghunath, N.M. 1982: Groundwater, Wiley Eastern.
Karanth, K.R. 1987: Groundwater assessmeny-development and management. Tata McGraw Hill.
Alley, W.M. 1993: Regional Groundwater quality, VNR, New York.
Subramaniam, V, 2000: Water. Kingston Publ. London.
S.P. Garg, Groundwater and Tubewells CBS Publication.
Reath R. C and Traniner . F. M. Introduction to Groundwater Hydrology.
Tolman. C. F. 1937 Groundwater.
Wisler, C.P and Brater E. F. 1962 Theory of Aquifer tests UsGs.
Chow V. T. (edi) 1964 Hand book of applied Geology.
Walton, W. C. 1970 Ground water Resource and Evaluation.

AGT 204 GEOCHEMISTRY (70 Marks)

- Introduction to the principles of geochemistry. Historical Geochemistry, Origin and cosmic abundance of elements.
- Goldschmidt's geochemical classification of elements.
- Comparative planetology: composition of the crust, mantle and core of the earth.
- Primary differentiation of earth. Distribution of elements in igneous, metamorphic and sedimentary rocks.
- Brief introduction to composition and classification of meteorites.
- Aspects of equilibrium thermodynamic- enthalpy and entropy, free energies, chemical potentials, fugacity and activity. Few problems related to thermodynamics.
- Secondary environmental geochemistry: causes and products of chemical weathering, chemical equilibria. Physico-chemical factors involved in distribution of elements in sedimentation, fench diagrams, their significance and application.
- Composition of hydrosphere with special reference to the composition of seawater and terrestrial waters. Gains and losses of the oceans. The balance of dissolved matter in seawater. Factors for the residence time of solids in seawater.
- Introduction to the evolution of atmosphere through geological time. Its gains and losses. Average composition of atmosphere. Anthrophogenic acidification and air pollution its effects and remedies.
- Isotope geochemistry: kinds of isotopes, natural and artificial radioactivity, variations of stable isotopes in igneous & metamorphic rocks. Basic concepts of isotopic palaeoclimatology, dating methods: Rb - Sr, U-Th-Pb, K- Ar, S, C and O. Use of trace and rare earth elemental chemistry in the genesis of minerals, rocks and ores.
- Computer aided techniques in geochemistry: Data collection and organization, quality controls of data recognition of noise and signals, sampling balanced and unbalanced sampling design, strategies for optimum sampling design;
- Mapping: Types of maps, class selection techniques, point symbol map, contour maps.

INTERNAL EVALUATION (30 Marks)

(Seminar + Term paper + Test)

Reference Books :-

Sr.No	Authors	Title	Publishers
1.	Mason and Moore;	Principles of Geochemistry.	John Wiley & Sons
2.	K. B. Krauskopf;	Introduction to geochemisty.	Mcgraw-Hill Publication
3.	A. W. Rose, H.E.Hawkes & J.S.Webb;	Geochemistry in Mineral Exploration.	Applied Publication
4.	Wadephol.	Handbook of Geochemistry.	--
5.	Govett. J. G. S.	Statistical Methods in Exploration Geochemistry.	Elsevier Publication
6.	Attila Vertes, Sandor Nagy & Karoly Suvegh.	Nuclear Methods in mineralogy & geology techniques & applications.	Plenum Press
7.	J. Hoefs	Stable isotope geochemistry	Springer-Verlag
8.	Bharat. B. Dhar	Mining and Environment	A.P.H. Pub. Cor.,New Delhi

PRACTICAL AGP 205 (Economic Geology + Indian Stratigraphy)

ECONOMIC GEOLOGY:- **(35 marks)**

- Study of Ore Microscope.
- Study of Typical Megascopic Ores.
- Study of Ores under Microscope.
  A) Optical Parameters.
  B) Determinative Mineralogy.
- Study of Ore Textures.
- Preparation of Paragenetic Sequence.
- Ore reserve calculation.
- Microchemical techniques.

INDIAN STRATIGRAPHY:- **(**35 marks)

Study and drawing of geological maps of different Supergroup and groups of India.

Preparation of palaeogeographic maps of India for different parts of India.

INTERNAL EVALUATION **(30 Marks)**
(Viva-voce + Journal + Data evaluation)

PRACTICAL AGP 206 (Hydrogeology + Geochemistry)

Hydrogeology **(3**5 marks)

- Preparation and interpretation of Hydrogeological maps.
- Computation of Hydraulic Gradient.
- Groundwater flow maps and flow net analysis, problem related to Darcy's law .
- Analysis of well inventory data, pump test analysis, field techniques and computation of aquifer parameters by different methods.
- Use of well logging techniques.
- Application of computer programs in solving groundwater problems.

GEOCHEMISTRY:- (35 marks)

- Brief outlines of analytical methods and instrumentation.
- Analysis of water quality for various purposes-agricultural, industrial and domestic; $_{P}H$, Conductivity, carbonate, Bicarbonate, Total Hardness, Chlorides, Sulfate and nitrates by titration. Estimation of Ca, Na, K by flame photometer and F, Br, I by Ion analyzer.
- Silicate analysis; Preparation of Solution 'A', Estimation of SiO_2 and Al_2O_3 preparation of solution B; Estimation of Total Fe, Na_2O and K_2O.
- Calorimetric Methods- Estimation of Cu, Zn, Mo.
- Determination of total heavy metals (bloom test) in water and soils.

INTERNAL EVALUATION **(30 Marks)**
(Viva-voce + Journal + Data evaluation)

EACH SEMESTER WILL HAVE 1 CREDIT (25 MARKS) FOR – FIELD TRAINING FOR LONG TOUR/IN PLANT TRAINING/INDUSTRIAL VISIT OR RECONNAISSANCE FIELD WORK DATA ACQUISITION RELATED TO DISSERTATION.