

**P.G. 3<sup>rd</sup> SEMESTER SYLLABUS**  
**DEPARTMENT OF GEOLOGY**  
**COTTON UNIVERSITY**

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**PAPER: GLY901C**

**GEODYNAMICS AND TECTONICS**  
(Credits: 3+1+0=4)

**THEORY:**

**GEODYNAMICS:** *Number of Lectures: 36*

**Internal structure of the Earth :** Elasticity theory; Seismic waves; Propagation of Seismic waves; Focal mechanism solutions of earthquakes; Seismic properties of rocks and minerals; Seismic Velocity within the Earth; Models of Earth's internal structure; Seismic tomography.

**Physical State of the Earth's Interior :** Constitutive Equations; Rheological Behavior of Rocks; Variation of *viscosity, density, pressure* and *temperature* of Earth materials; Magnetic behavior of Rocks & Minerals.

**Mineral physics :** Thermodynamics of the crystals; Mineralogical make-up of the mantle; High pressure-temperature Phase Transitions in transition zone and lower mantle; Modern Techniques in mineral physics: theory & experiments.

**Physics of Heat Flow :** Heat Transfer equation; Heat source within Earth; Heat Transport in Earth; Equation of heat conduction; Thermal Conductivity of the Earth; Thermal state of the Earth's interior; Thermal stress; Diffusion, Viscosity, and Flow of Melts; Mantle geotherms.

**Mantle Dynamics :** Energy in the Mantle of the Earth; Role of Fluids in mantle processes; Mantle convection; Evolution of upper mantle; Mantle downwelling: subducting slabs; Dynamics of Mid-ocean ridges (MORs); Mantle plumes & Hotspots.

**Core Dynamics :** Mineralogy of the Earth's Core; Energy of the Core; Flow in the core: compositional and thermal; Magneto-hydrodynamics Theory: Concept of Geodynamo; Magnetic polarity reversals; Core-Mantle interactions..

**TECTONICS: (12L)**

Crustal & Lithospheric structure; Rheology of plates; Lithospheric deformation: buckling, bending and flexure of plates; Thermal structure of lithosphere; Magmatism and magma chambers; Dynamics of Continental Breakup and Extension; Dynamics of mountain building process; Transform Faults; Triple junctions; Palaeomagnetism; Motion of lithospheric plates.

***Recommended Books:***

1. Geodynamics (1982) - D Turcotte & G Schubert, *Cambridge University Press*.
2. Mantle convection in the Earth & Planets (2001) - D Turcotte, G Schubert & P Olson, *Cambridge University Press*.
3. Fundamentals of Geophysics (2007) - W Lowrie, *Cambridge University Press*.
4. Introduction to Seismology (1999) - P.M. Shearer, *Cambridge University Press*.
5. Rheology of the Earth (1995) - G Ranalli, *Springer*.
6. Global Tectonics (2009) - P Kearey, K A Klepeis, F J Vine, *Wiley-Blackwell*.

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7. Solid Earth (2004) - C M R Fowler, *Cambridge University Press*.

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**PAPER: GLY902C**

**COAL AND PETROLEUM GEOLOGY**  
(Credits: 3+0+1=4)

**THEORY**

**COAL:** *Number of Lectures: 24*

Definition and origin of coal: Sedimentology of coal bearing strata, types of seam discontinuities and structures associated with coal seams.

Chemical analysis of coal: Proximate and Ultimate analysis.

Classification of coal: ASTM classification, Seyler's classification, International classification; Indian classification for coking and non-coking coals.

Coal Petrography – Concept of lithotype, maceral and microlithotype, optical methods to evaluate the coal rank.

Coal utilization: Elementary idea about coal preparation, coal carbonization, coal gasification, coal hydrogenation, coal combustion.

Coal bed methane: New energy resource, maturation of coal and generation of methane in coal beds.

Geological and geographical distribution of coal deposits in India.

**PETROLEUM GEOLOGY:** *Number of Lectures: 40*

Origin of petroleum: Identification and characterisation of Source rock, Environments and processes of transformation of source material to petroleum, Biogenic and Thermal effect, Theories of origin of petroleum, Organic geochemical indicators of dynamic fluid flow processes of petroleum.

Reservoir: Classification and petro-physical properties of reservoir rocks, Pressure conditions in reservoir, Reservoir fluids and factors affecting fluid distribution, Phase behaviour of hydrocarbon systems.

Migration of petroleum: primary and secondary, forces responsible for migration, migration routes and barriers.

Trap: Characteristics and Classification, structural, stratigraphic, combination and fluid barrier traps.

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Oil well drilling: conventional drilling, horizontal drilling, slant drilling, directional drilling.

Drilling fluids: composition and properties of drilling fluid.

Geophysical exploration for hydrocarbon: Gravimetric surveys, Seismic surveys, Wireline logging: principles and interpretations of electrical logs: self-potential and resistivity logs, Natural gamma ray log; Use of well logging in stratigraphic correlations.

Geographic and Stratigraphic distributions of oil and gas; Structure and Geology of petroliferous basins of India, Structure and Geology of important oil & gas fields of NE India.

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**PRACTICAL**

**COAL:**

Study of coal in hand specimen.

Identification of different types of coal, lithotypes, coke.

Proximate analysis of coal: determination of moisture, ash and volatile matter.

Study of polished block and thin section under microscope.

Coal reserve estimation.

**PETROLEUM GEOLOGY:**

1. Preparation of structure contour and isopach maps of reservoir facies and drawing oil/water contact from bore hole data.

2. Laboratory practice on geologic interpretation of wire-line log response and calculation of petro-physical attributes.

3. Study of geological maps and sections of important oilfields of India.

4. Calculation of oil reserve.

**Recommended Books:**

1. Textbook of Coal (Indian context) - D. Chandra, R. M. Singh and M. P. Singh, *Tara Book Agency*, Varanasi.

2. Coal Geology - Larry Thomas, *Wiley-Blackwell*.

3. Coal and Coal-bearing Strata: Recent Advances - A. C. Scott, The geological Society of London, Publication No. 32, *Blackwell Scientific Publications*.

4. Coal and Organic Petrology - M. P. Singh, *Hindustan Publishing Corporation*, New Delhi.

5. Textbook of Coal Petrology - E. Stach, *Gebruder Bomtraeger*, Stuttgart.

6. Petroleum Geology – F.K. North; *Allen & Unwin*, London

7. Basic Well Log Analysis for Geologists – G. Asquith and C. Gibson; *Academic Press*, London

8. Statistics and Data Analysis in Geology – J.C. Davis; *John Wiley & Sons*, New York

9. Geostatistical Reservoir Modelling – C.V. Deutsch; *Oxford Univ. Press*, Oxford.

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**PAPER: GLY903C**

**HYDROGEOLOGY**

**(Credits: 3+0+1=4)**

**THEORY:** *Number of Lectures: 48*

Concepts of hydrologic cycle; Precipitation, Run off; Hydrograph: Components, Base flow separation; Factors governing shape of hydrograph.

Origin and sources of groundwater; concept of groundwater age dating; Rock properties affecting groundwater; Types of Aquifers: Confined, Unconfined, Leaky aquifer, Bounded aquifers; Anisotropy and heterogeneity; Storage coefficient, Specific storage.

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Basic principles of Groundwater flow: Hydraulic gradient, Groundwater flow rate and flow direction; Steady-state flow and Unsteady-state flow; Intrinsic permeability, Hydraulic conductivity, Transmissivity.

Groundwater level fluctuations- Secular, Seasonal and Diurnal variations; Factors governing groundwater fluctuations, Fresh and salt water relationship in coastal area, Prevention and control of sea water intrusion.

Physiochemical characteristics of groundwater: Principal chemical constituents in groundwater, Physical, Chemical and Biological analysis; Changes in chemical composition; Quality criteria for drinking, Irrigation and industrial uses; Groundwater pollution and Contaminations.

Basic principles of well hydraulic: Drawdown and Cone of depression, Steady state and Nonsteady state flow, Non-equilibrium equation for pumping tests, Step drawdown test and Aquifer performance test, Analysis of pumping test data.

Surface and sub-surface investigation of groundwater; Hydrogeological mapping; Systematic and reappraisal survey by well inventory method; Geophysical methods of exploration;

Groundwater exploration by test drilling; Basic concepts of use of remote sensing and GIS in groundwater exploration.

Methods of construction of shallow wells, Methods of drilling, design criteria and Development of tube wells.

Hydrologic budget: equation of hydrologic equilibrium; Concept of groundwater reserve- static and dynamic reserve; Groundwater assessment, Artificial recharge, Principles of Sustainable Groundwater Development and Management.

**PRACTICAL** *Number of Practicals : 16*

Analysis of rainfall data and well hydrograph. Estimation of average annual rainfall.

Interpretation of topographic map, geologic map, aerial photograph and satellite imagery for groundwater prospect evaluation.

Determination of porosity, permeability, effective size, uniformity coefficient and design of well screen and gravel pack from mechanical analysis data of aquifer materials.

Graphical representation of groundwater chemical analysis data and water classification.

Preparation and interpretation of depth to water level map, water table map, hydrogeological sections, panel diagram.

Estimation of groundwater recharge.

Computation of aquifer and well characteristics from Aquifer Performance Test (APT) and Step Drawdown Test (SDT).

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**Recommended Books:**

1. Field Hydrogeology - Brassington, R., (2007), 3<sup>rd</sup> Edn., *John Wiley & Sons, Ltd.*
2. Hydrogeology - Davis, S. N., and DeWiest, R. J. M., *John Wiley & Sons, New York.*
3. Applied Hydrogeology - Fetter, C. W., Second Edn. *CBS Publishers & Distributors, Delhi, India.*
4. Ground Water - Edited by P. S. Pitchaiah, *Scientific Publishers, Jodhpur, India.*
5. Hydrology: Principles, Analysis and Design - H. M. Raghunath., *Wiley Eastern Ltd.*
6. Hydrogeology Principles and Practice - Hiscock, K. M., (2005), *Blackwell Publishing.*
7. Groundwater assessment development and management - Karanth, K. R., (1987), *Tata Mc Graw-Hill, New Delhi.*
8. Analysis and Evaluation of Pumping Test Data - Kruseman, G. P. and de Ridder, N. A., (1994). Second Edn., Pub. 47, *International Institute for Land Reclamation and Improvement, Wageningen, The Netherlands, 372 p.*
9. Groundwater recharge. A guide to understanding and estimating natural recharge - Lerner D. N., Issar A. S. and Simmers I., (1990), *IAH Int Contrib Hydrogeol 8. Heinz Heise, Hannover, 345 p.*
10. Groundwater and tube well irrigation, A text book on - Hydrology and water resources - Sarma, R. K. and Sharma, T. K., (1987), *Dhanpet Rai and Sons, New Delhi.*
11. Ground water Hydrology - Todd, D. K. and Mays, L. W., (2005), 3<sup>rd</sup> edn. *Hoboken: John Wiley & Sons.*
12. Ground water Hydrology - Todd, D. K., (2006), 2<sup>nd</sup> ed., *John Wiley & Sons, New York.*
13. Hand Book of Ground Water Vol. I Ground Water and contamination - U.S. Environmental Protection Agency (USEPA), (1994), *Scientific Publishers, Jodhpur, India.*
14. Hydrology - Wisler, C. O. and Brater, B. F., (1959), *New York: Willey.*

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**(Special Paper)**

**PAPER: GLY904S**

**GEOEXPLORATION AND MINING GEOLOGY**  
**(Credits: 4+0+1=5)**

**Geoexploration:** *Number of Lectures: 40*

Surface and subsurface studies in mineral exploration; Sampling; Classification and computation of ore reserves;

Geological prospecting; Principles; prospecting criteria and guides and methods

Geochemical prospecting: Principles; Methods – Stream sediment survey, pedogeochemical, lithogeochemical, hydrogeochemical, fluid inclusion, and geobotanical prospecting methods.

Geophysical prospecting: Principles, Methods – Magnetic, gravity, electrical, electromagnetic, seismic, radioactive; Borehole geophysics and geothermal method.

Geostatistical techniques in mineral exploration.

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**Mining Geology:**

*Number of Lectures: 24*

Unit operations in mining: drilling and rock penetration, blasting and rock fragmentation, loading and excavation, haulage and hoisting; Auxiliary operations in mining;

Mine planning and design; Dilution in mining;

Surface and underground mining methods

Coal Mining methods; Valuation of a mine- factors and methods;

Environmental impact of mining

**PRACTICAL** *Number of Practicals :16*

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Interpretation of geophysical logs for geological purpose; application of geophysical data in mineral exploration - gravity data, magnetic data, electrical data; utility of seismic reflection data in recognition of subsurface structures; interpretation of seismic data.

Determination and evaluation of ores in mines; different sampling calculations; recoverable values; cost of mining; future cost and profits; life of mine; determination of present value of mines; cross section of mines with the help of available data.

***Recommended Books:***

1. Kearey P, Brooks M, Hill I (2002) *An Introduction to Geophysical Exploration*, 3rd Edition. Blackwell Science.
2. Moon CJ, Whateley MKG, Evans AM (2006) *Introduction to Mineral Exploration*, 2nd Edition. Blackwell Publishing.
3. Marjoribanks RW (1997) *Geological Methods in Mineral Exploration and Mining*. Chapman & Hall, London.
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4. Chugh CP (1992) *High Technology in Drilling and Exploration*. Oxford & IBH, New Delhi.
5. Rose AW, Hawkes HE, Webb JS (1979) *Geochemistry in Mineral Exploration*. Academic Press, London.
6. Kuzvart M, Bohmer M (1986) *Prospecting and Exploration of Mineral Deposits*. Elsevier, Amsterdam.
7. Edwards RP, Atkinson K (1986) *Ore Deposit Geology and its Influence on Mineral Exploration*. Chapman & Hall,
8. N.Y. Sinclair AJ, Blackwell GH (2004) *Applied Mineral Inventory Estimation*. Cambridge University Press, U.K.
9. Singer DA, Menzie WD (2010) *Quantitative Mineral Resource Assessments*. Cambridge University Press, U.K.
10. Journel AG, Huijbregts CJ (1978) *Mining Geostatistics*. Academic Press, London.
11. Rollinson HR (1993) *Using Geochemical Data*. Longman, New York.
12. Jeffery PG, Hutchinson D (1981) *Chemical Methods of Rock Analysis*. Pergamon Press, Oxford

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(Open Elective)

**PAPER: GLY905P**

**DIGITAL REMOTE SENSING**

(Credits: 3+0+1=4)

**THEORY:** *Number of Lectures: 48*

Remote Sensor and their classification.

Digital Imaging Sensor: Working principle and components; Concept of Digital Image; Sensor Resolutions; Types scanning system (Cross-track scanner, Along track scanner, Side scanning system, Circular scanner); Digital imaging by non-scanning system; Multispectral imaging system; Colour Composite Image; Satellite orbits; Orbital characteristics of Remote Sensing Satellite; Space Remote Sensing missions (Landsat, SPOT, IRS, GeoEye, DigitalGlobe); Types of Satellite Data Products; Concept of hyperspectral data and their importance.

Photographic Sensor: Definition and history of Aerial Photography; Geometric elements of Aerial Photograph; Structure and spectral sensitivity of films; Filters; Characteristics of Aerial Photographs (Resolving power, Ground Resolution, Scale, Relief Displacement); Photographic flight mission and layout, Types of photographic Distortion and Displacement; Theory of Stereoscopy; Vertical Exaggeration; Principles and basic aspects of Photogrammetry; Image Parallax; Measuring heights from Relief Displacement and Parallax measurement; Instruments used in photo interpretation.

Microwave Remote Sensing: Radar development; SLAR System; Viewing Geometry of radar system; Spatial Resolution of SLAR Systems; Synthetic Aperture Radar (SAR); Geometric characteristics of Radar imagery - Scale distortion, Relief Displacement, Parallax and Speckle; Transmission characteristics of Radar signals – Wavelength and Polarization; Surface roughness and Electrical characteristics; Interpretation of radar image; Advantages of Radar Imagery for Geological Applications; Microwave Remote Sensing Satellite.

Thermal Remote Sensing: Thermal Infrared radiation; Kinetic and Radiant Temperature; Thermal properties of materials; characteristics of thermal images; Temperature mapping; Thermal Remote Sensing Sensor; Thermal image interpretation.

Concept of LiDAR remote sensing.

Concept of hyperspectral remote sensing;

Digital Image Processing: Image rectification and restoration (Geometric corrections, Radiometric corrections and Noise removal); Image Enhancement (Contrast manipulation and Spatial feature Manipulation); Multi-image manipulation (Spectral ratioing, Principal and Canonical Components and Vegetation Components); Multispectral classification – Supervised and Unsupervised.

Application of Remote Sensing in Geomorphology, Structure & Lithology Mapping, Mineral exploration, Groundwater investigation, Engineering geology, Environmental surveillance and Natural hazard mitigation.

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**PRACTICAL:** *Number of Practicals: 16*

Visual interpretation of satellite image and aerial photograph for interpretation of geomorphology, landform, lineament, lithology, structure and landuse.  
Use of Image Processing Software for Image Enhancement, Multi-image manipulation and image classification.

***Recommended Books:***

1. Remote Sensing – Principles and Interpretation. F.F. Sabins; W.H. Freeman and Company
2. Principles and Applications of Photogeology. S.N.Pandey; New Age International Publishers.
3. Remote Sensing Geology. R.P. Gupta; Springer-Verlag.
4. Remote Sensing and Image Interpretation. T.M. Lillesand and R.W. Kiefer; John Wiley and Sons, Inc.
5. Remote Sensing and GIS. Basudeb Bhatta; Oxford University Press
6. Image Interpretation in Geology. S.A. Drury; Allen and Unwin (Publishers) Ltd.
7. Photogeology. V.C. Millere and C.F. Miller; McGraw-Hill Book Company, Inc.
8. Remote Sensing of the Environment – An Earth Resource Management. J. R. Jensen, Pearson Education, Singapore.

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