School of Earth, Ocean and Climate Sciences

Q-Exam subject & Syllabus

Geology

Subject Name: Sedimentology

Syllabus:

Various Sedimentary structure and its relationship with grain size and depositional environment, Sedimentary textures, Sedimentary depositional environments, Evolution of sedimentary basins- tectonics and sedimentation, Sedimentary cycles, Environment and facies, Marine transgression and regression, Walther's law of facies and applications.

Reference Books:

1. Maurice Tucker, *Sedimentary Petrology*, Wiley-Blackwell.
2. Harold G. Reading, *Sedimentary Environments: Processes, Facies and Stratigraphy*, Wiley-Blackwell.
3. D. R. Prothero & Fred Schwab, W. H. Freeman, *Sedimentary Geology*, Wiley-Blackwell.
4. Sengupta Supriyo, Introduction to Sedimentology

Subject Name: Geochemistry

Syllabus:

Concepts in Geochemical Systems. Concept of equilibrium. Chemical equilibrium. Fundamental Relationship in Classical Thermodynamics, Thermodynamics of simple systems, The Phase Rule. Structure and composition of earth and distribute of elements. Cosmic abundance of elements. Trace elements. Elementary crystal chemistry and thermodynamics. Oxidation-Reduction Reaction. Oxidation Potential and Eh-PH Diagrams. Geochemical cycles and principles of geochemical prospecting. Activity coefficients of dissolved species. Metal ions in aqueous solutions. Carbonate chemistry and pH control, clay minerals and ion exchange; adsorption-desorption reactions, stability relationships and silicate equilibria; mineral stability diagrams, chemical weathering and water chemistry. Rates of geochemical reactions.

Shallow earth interactions in emphasizing: Groundwater geochemistry; Elemental cycles linked to biological activity in the oceans; Geochemistry and global climate cycles; Geo-bioremediation and applied analytical techniques, Studies of oxygen, carbon isotopes and their applications, Application of isotopes in climate change.

Reference Books:

1. C.A.J. Appelo, D. Postma, *Geochemistry, Groundwater and Pollution*, Taylor & Francis.
2. Broder J. Merkel, Britta Planer-Friedrich , Darrell K. Nordstrom, *Groundwater Geochemistry: A Practical Guide to Modeling of Natural and Contaminated Aquatic Systems :*Springer.
3. François M. M. Morel, J. G. Hering, *Principles and Applications of Aquatic Chemistry,* Wiley-Interscience.

Subject Name: Analytical Methods in Geosciences

Syllabus:

Concepts in analytical chemistry; Classical and rapid methods of analyses of geological samples; Atomic absorption spectrometry; Inductively coupled plasma-atomic absorption spectrometry and Mass Spectrometry; X-ray fluorescence analysis; Energy and wavelength dispersive X-ray spectrometry; X-ray diffraction analysis; micro beam and surface analysis techniques; neutron activation analysis, Analysis of organic and inorganic carbon in water and sediments samples, utilization of High Performance Liquid Chromatography techniques in the geological samples. Stable Isotope analysis of geological samples.

Reference Books:

1. Potts, P.J., *A Handbook of Silicate Rock Analysis*, Springer.
2. Thompson, M. and Walsh, J.N., *A Handbook of Inductively Coupled Plasma Spectrometry*, *Chapman and Hall.*
3. Van Loon, J.C., *Analytical Atomic Absorption Spectroscopy*, Academic Press.
4. Jeffery, P.G. and Hutchinson, D., *Chemical Methods of Rock Analysis*, Butterworth-Heinemann.

Atmosphere

Subject Name: Concepts in Earth System Science

Syllabus:

Weather and climate, composition of atmosphere, radiation in the atmosphere, Air temperature and pressure, atmospheric moisture, properties of sea water, definition and measurement of oceanic parameters, basic physical laws, classification of forces in oceanography and meteorology and, atmospheric and oceanic motions.

Earth as a planet; size, shape and mass of Earth. Relative and absolute age-dating of Earth. Earthquakes and seismic waves; Earth's internal structure; Earth's magnetic and gravity fields; palaeomagnetism. Continental and oceanic crust; Continental drift; Ocean floor

spreading; Plate Tectonics. Structure of Atmosphere and related phenomena, Origin and Evolution of ocean basins, Ocean Circulation, Global Warming; causes and effects Composition of the earth; characteristics and elemental abundance in different layers. Geological processes operating on the surface of earth.

Reference Books:

1. Wallace, J.M. and Hobbs, P.V. (2006) Atmospheric Science: An Introductory Survey (Vol. 92). Academic Press, Cambridge.
2. Trujillo and Thurman(2010). Essentials of Oceanography

Subject Name: Organic Geochemistry

Syllabus:

Origin of Organic matter in natural systems, Classification and separation of different organic matter fractions, Humic substances in soils, sediments and water and their extraction, interaction of naturally produced humic substances with the sediments. Methods of quantification of organic matter.

Atmospheric organic geochemistry, Carbonaceous species in ambient aerosols, Water-soluble and Poly Aromatic Hydrocarbons (PAHs), Carbon stable isotope geochemistry, Use of Carbon isotopes (^{13}C and ^{14}C) for source identification and past climatic conditions, Organic matter degradation and preservation, Global Carbon cycle, Soil carbon and turn over rates. Biomarkers in petroleum industry, Organic tools in petroleum exploration. Determination of organic and inorganic carbon content in the geological samples and their characterization.

Reference Books:

1. K.E. Peters, C.C. Walters, J.M. Moldowan, *The Biomarker Guide: Volume 1 & 2, Biomarkers and Isotopes in the Environment and Human History*, Cambridge University Press.
2. Stephen D. Killops, and Vanessa J. Killops, *An Introduction to Organic Geochemistry* :Wiley.
3. András Gelencsér, *Carbonaceous Aerosol, Atmospheric and Oceanographic Sciences Library.*

Subject Name: Meteorology and Oceanography

Syllabus:

Thermodynamics of dry air, thermals; Thermodynamic of moist air: thermodynamic properties of water; Clausius-Clapeyron (C-C) equation, moist processes in the atmosphere, adiabatic; saturated and unsaturated accent, Thermodynamic diagrams, Moist convection, formation of cloud droplets, precipitation, thermodynamics of sea water.

Reference Books:

1. Wallace, J.M. and Hobbs, P.V. (2006) Atmospheric Science: An Introductory Survey (Vol. 92). Academic Press, Cambridge.
2. Holton, J. R. (1973). An introduction to dynamic meteorology. *American Journal of Physics*, *41*(5), 752-754.
3. John A. Knauss (2016). *Introduction to physical oceanography*
4. Lynne D. Talley (2011).Descriptive physical oceanography : an introduction, Academic Press
5. S. Pond and G L Pickard (2013) Introductory Dynamical Oceanography, Butterworth-Heinemann
6. Avijit Gangopadhyay(2022). Introduction to Ocean Circulation and Modeling

Subject Name: Fluid Dynamics in Earth System Sciences

Syllabus:

Fluid continuum, fluid statics, surface and body forces in fluids, Coriolis force, continuity and Navier- Stokes equations, vorticity and divergence, Rossby number, balanced flow: Geostrophic Flow, Inertial Flow, Cyclostrophic Flow and Gradient Flow, equations of motion in rotating frame, potential vorticity conservation, simplified equations for ocean and atmosphere, Thermal Wind, geostrophic wind.
Kinematics of Pressure Fields. Streamlines, and stream functions, Hydrostatic approximation, geostrophic approximation, quasi-geostrophic analysis, quasi-geostrophic motion in equatorial area. Atmospheric Instabilities: Dynamical instabilities, Barotropic instability, Baroclinic inertial instability, Necessary condition of Barotropic and Baroclinic instability. Combined Barotropic and Baroclinic Instability. Kelvin - Helmholtz Instability.

Reference Books:

1. Pedlosky, J. (1987). *Geophysical fluid dynamics* (Vol. 710, pp. 10-1007). New York: springer.

2. Holton, J. R. (1973). An introduction to dynamic meteorology. *American Journal of Physics*, *41*(5), 752-754.
3. Gill, A. E., & Adrian, E. (1982). *Atmosphere-ocean dynamics*(Vol. 30). Academic press.

Subject Name: Tropical Climate System

Syllabus:

Tropical weather systems, general circulation in the tropics, distribution of temperature, moisture, radiation, precipitation and evaporation in the tropics, convective systems and thunderstorms. Cloud classification, condensation nuclei, growth of cloud drops and ice-crystals, precipitation mechanisms. Inter tropical convergence zone, trade winds, theory and observation of tropical waves,heat induced tropical circulations, Synoptic scale weather systems: Lows, Highs, Easterly waves, Depressions. Tropical Cyclones: Life Cycle, structure in wind, temperature etc., Eye and Wall, Spiral cloud bands, Intensity. Large scale planetary systems: Equatorial Trough, ITCZ, Trade wind, Hadley and Walker circulations, Jet Streams, El Nino Southern Oscillation, Tropical Biennial Oscillation, Tropical Stratosphere.
Indian summer Monsoon: SW and NE monsoon, mechanisms, onset and advance of monsoon, inter-annual and intraseasonal variability, factors influencing monsoon.

Reference Books:

Krishnamurti, T. N., Stefanova, L., & Misra, V. (1979). *Tropical meteorology*. Secretariat of the World Meteorological Organization.

Asnani, G. C. (1993). *Tropical meteorology*. Asnani, Indian Inst. of Tropical Meteorology.

Subject Name:Physical Oceanography

Syllabus:

Action of wind on ocean surface; Ekman's theory and derivation; upwelling and sinking. Inertial currents; divergences and convergences; geostrophic currents; Gradient motion, Wind driven coastal currents (WBC and EBC); Vertical profiles of temperature and salinity in sea water. Mixed layer Depth, Thermocline. Properties of sea water and their distributions, measurements in the ocean, mixed layer and thermocline.

Reference Books:

1. John A. Knauss (2016). *Introduction to physical oceanography*

2. Lynne D. Talley (2013).Descriptive physical oceanography : an introduction, Academic Press
3. S. Pond and G L Pickard (2003). Introductory Dynamical Oceanography, Butterworth-Heinemann
4. Avijit Gangopadhyay (2022). Introduction to Ocean Circulation and Modeling

Subject Name: Earth System Modelling

Syllabus:

Introduction: Mesoscale Processes; Scale analysis; Governing Equations; Finite difference Techniques- Explicit, Implicit Schemes and Semi Implicit Schemes; Vertical Co-ordinate Systems and Grid structures- Staggered and un-staggered grid, Map Projections; Finite Element Method, Stability; Nonlinear Instability and Aliasing.

Parameterization and initialization: Basic Concepts of Parameterization, Boundary layer Parameterization, Cumulus Convection and Radiation parameterization, Data assimilation – verification and validation of mesoscale models - nowcasting and forecasting. Formulation of mesoscale numerical models.

Reference Books:

1. Jacobson, M. Z. *Fundamentals of atmospheric modeling*. Cambridge university press.
2. Kendal McGuffie, Ann Henderson-Sellers. *A Climate Modelling Primer.* Wiley