

Gondwana University, Gadchiroli



**Board of Studies in Geology
Faculty of Science**

Choice Based Credit System (CBCS)

**Syllabus of
M.Sc. (Geology)
Semester III & IV
(Two Years Degree Course)**

Prepared by
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Chairman BOS Geology
2017-2018

SYLLABUS for M. Sc. GEOLOGY
Choice Based Credit System (Semester Pattern)
GONDWANA UNIVERSITY GADCHIROLI 2017-18
M.Sc. GEOLOGY Semester III

Code	Theory / Practical	Teaching Scheme (Hrs/ week)			Credits	Examination Scheme					
		Th	Pr.	Total		Duration (Hrs)	Max. Marks		Total Marks	Min. Passing Marks	
							External	Internal		Th	Pr.
Core 9	PSCGEOT09 Hydrogeology and Watershed Management (3+1)	4		4	4	3	80	20	100	40	
Core 10	PSCGEOT10 Geomorphology, Remote Sensing and GIS (1+2+1)	4		4	4	3	80	20	100	40	
Core Elective 1	PSCGEOT11 (Any one) E1.1 Mining Geology and Mineral Exploration (1+3) E1.2 Environmental Geology & Engineering Geology (2+2) E1.3 Petroleum Exploration (4) E1.4 Quaternary Geology and Limnogeology (3+1)	4		4	4	3	80	20	100	40	
Foundation Course 1	PSCGEOT12 Foundation Course 1 FC-1.1 Introduction to Geology (or) FC-1.2 Economic Geology	4		4	4	3	80	20	100	40	
Pract. Core 9 & 10	PSCGEOP05 Hydrogeology & Watershed Management, Geomorphology, Remote Sensing & GIS (Marks: 75 Pract. Exam. + 05 viva-voce + 20 Internal Assessment and Class Record)		8	8	4	3	80	20	100		40
Pract. Core Elective 1	PSCGEOP06 Based on Paper 11 (Marks: 75 Pract. Exam. + 05 viva-voce + 20 Internal Assessment and Class Record)		8	8	4	3	80	20	100		40
Seminar	Seminar 3	2		2	1	---		25	25	10	
Total		18	16	34	25		480	145	625	170	80

Core 9

PSCGEOT09: Hydrogeology and Watershed Management

Unit I:

Hydrological cycle; Controls of geology on groundwater occurrence, movement and distribution; Classification of aquifers and aquifer systems; Mode of occurrence of groundwater in different geological formations and groundwater provinces of India; Darcy's law and Reynolds number; Aquifer parameters; Water table contour maps and flow net analysis; Seepages and springs.

Unit II:

Groundwater quality and environmental aspects; Chemical characteristics of groundwater in relation to various uses – domestic, industrial and irrigation; Saline water intrusion in coastal and other aquifers and its preventive measures; Environmental effects of over-exploitation of groundwater; Water logging problems; Causative factors of groundwater level fluctuations and environmental influences; Radioisotopes in hydrogeological studies.

Unit III:

Surface and subsurface methods of groundwater exploration; Application of remote sensing in groundwater exploration; Collection of hydrogeological data and preparation of hydrographs; Selection of suitable site for well construction; Type and design of wells, methods of well construction, well completion and well development; Pump tests and evaluation of hydrologic properties through various methods for steady and unsteady flow.

Unit IV:

Artificial recharge to groundwater and rainwater harvesting; Management of groundwater resources; Conjunctive use of groundwater and surface water; Concept of watershed: Watershed characters, importance of water resources; Technical aspects of artificial recharge structures; Groundwater legislation; Role of NGOs and government policies in watershed development.

Practical:

Delineation of hydrological boundaries on water-table contour maps and estimation of permeability; Determination of groundwater flow direction; Problems in calculating transmissivity, specific retention and specific yield; Interpretation of well inventory data; Analysis of hydrographs and estimation of infiltration capacity; Pumping test: time-drawdown and time-recovery tests and evaluation of aquifer parameters; Step drawdown tests, Electric resistivity sounding for delineation of fresh aquifers; Study of geophysical well logs; Estimation of TDS using resistivity and SP logs; Exercises on groundwater exploration using remote sensing techniques; Water budgeting problems.

Books Recommended:

Davies, S.N. and De Wiest, R.J.N. (1966) Hydrogeology, John Wiley and Sons, New York.
Driscoll, F.G. (1988) Groundwater and Wells, UOP, Johnson Div. St. Paul. Min. USA.
Karanth, K. R. (1989) Hydrogeology, Tata McGraw Hill Publishers.

Nagabhushaniah, H.S. (2001) Groundwater in Hydrosphere (Groundwater hydrology), CBS Publ.
Raghunath, H.M. (1990) Groundwater, Wiley Eastern Ltd.
Todd, D.K. (1995) Groundwater Hydrology, John Wiley and Sons.
Tolman, C.F. (1937) Groundwater, McGraw Hill, New York and London

Core 10

PSCGEOT10: Geomorphology, Remote Sensing and GIS

Unit I:

Geomorphic concepts; Landforms: Role of Lithology, peneplanation, endogenous and exogenous forces responsible, climatic and tectonic factors and rejuvenation of landforms; Denudational processes: Weathering, erosion, transportation, weathering products and soil formation, slope processes; Drainage basin morphometry; Major processes and associated landforms: Tectonic, fluvial, aeolian, coastal, karst and glacial; Geomorphic features and zones of India.

Unit II:

Fundamentals of EMR, radiation laws, black and grey body radiation, atmospheric effect in remote sensing; Interaction of EMR with atmosphere and Earth surface; Interaction of TIR wavelength with terrain feature and vegetation; Interaction of Microwave with Earth surface.

Aerial photography: Sequence involved in the aerial photography: Types, stereoscopy, geometrical characteristic, film and filter; Instrumentation and vertical exaggeration; Calculations of heights and slopes from aerial photographs; Principles of photogrammetry; Aerial photo interpretation – photo recognition elements and Interpretation of different geological features on B/W aerial photographs.

Unit III:

Orbit and Sun-synchronous aspect of satellite; Remote Sensing Sensor: Platforms and sensor resolution and calibration aspects of remotely sensed data, microwave sensor and False Colour Composite (FCC); Fundamentals of digital image processing: Image rectification, Image enhancement and Image classification; TIR remote sensing and its applications; Principle of microwave remote sensing and its applications; Geological applications of remote sensing; LANDSAT, SKYLAB, SPOT, SEASAT, ICONOS and other foreign systems of satellites and their interpretation for geological studies; Space research in India: Bhaskara, IRS series and their applications.

Unit IV:

Principles and components of GIS; Geospatial data, data for GIS application, spatial data models and data structures; Vector and raster based GIS; Spatial data acquisition, Vector overlay analysis; Neighbourhood Operation; Raster spatial analysis; Buffer analysis; Visualization and query of spatial data; Overlay analyses; Terrain analysis (DEM); Line generation; Introduction to GIS and remote sensing software; Geological applications of GIS; Principle and application of GPS.

Practical:

Topographical map interpretation for different landforms; Analysis of weathering trends; Drainage basin morphometry; Relief and slope analyses; Determination of photo scale, aerial photo interpretation for geological and geomorphological applications, parallax measurements for height determination, dip and thickness of beds; Study of landforms and interpretation of lithology and structure from aerial photograph and satellite images; Tracing of lineament and rosettes; Identification of landform on toposheets, aerial photographs and satellite images; Generation of DEM and DTM; FCC interpretation of satellite images; Image processing and GIS software.

Books Recommended:

Geomorphology:

Kale and Gupta, Introduction to Geomorphology.

Rice, Fundamentals of Geomorphology.

Sharma, H.S. (1990) Indian Geomorphology, Concept Publishing Company, New Delhi.

Thornbury, W.D. (1980) Principles of Geomorphology, Wiley Easton Ltd., New York.

Remote Sensing and GIS:

Anji Reddy, M. (2001) Textbook of Remote Sensing and Geographical Information Systems, BS Publication, Hyderabad.

Berhardsen, T. (1999) Geographic Information System: an introduction, Wiley, New York.

Bonham-Carter, G.F. (1994) Geographic Information System for Geoscientists: Modelling with GIS, Pergamon.

Burrough, P.A. (1986) Principles of Geographical Information Systems for land resources assessment, Clarendon Press, Oxford.

Burrough, P.P. and MacDonnel, R.A. (1998) Principles of GIS, Oxford University Press.

Curran, P.J. (1985) Principles of Remote Sensing, Longman Scientific & Tech. Group, Essex, England.

Drury, S.A. (2001) Image Interpretation in Geology, Chapman and Hall, London.

Gupta, R.P. (1991) Remote Sensing Geology, Springer-Verlag.

Jain, A.K. (1989) Fundamentals of digital image processing, Prentice Hall India.

Jensen, J.R. (1986) Introductory Digital Image Processing: A Remote Perspective, Prentice Hall, New Jersey.

Lattman, L.H. and Ray, R.G. (1965) Aerial photographs in field geology, McGraw Hill.

Pande, S.N. (1987) Principles and Applications of Photogeology, Wiley Eastern Limited.

Lillesand, T.M. and Kiefer, R.W. (2000) Remote Sensing and Image Interpretation, John Wiley and Sons Inc., New York.

Maguire, D.J., Goodchild, M.F. and Rhind, D.W. (1991) GIS - Principles and Applications, Longman Scientific and Technical.

Mikhail, E.M. (1980) Photogrammetry, Harper and Row.

Miller, V.C. (1961) Photogeology, McGraw Hill.

Paine, D.P. (1981) Aerial photography & Image Interpretation for Resource Management, John Wiley

Ray, R.G. (1969) Aerial Photographs in Geologic Interpretations, USGS Proc Paper 373.

Richards, J.A. (1986) Remote Sensing Digital Analysis: an introduction, Springer-Verlag, Berlin.

Sabins, F.F. Jr. (2000) Remote Sensing Principles and Interpretations, W.H. Freeman & Company, USA

Siegel, B.S. and Gillespie, A.R. (1980) Remote Sensing in Geology, John Wiley.

Core 11

PSCGEOT11: Core Elective 1

E1.1 Mining Geology and Mineral Exploration

Unit I:

Application of Geology in mining; Geological work at an operating mine; Guides in the location of ore deposits- physiographic, lithologic, stratigraphic, mineralogic and structural guides; Intersecting loci and ringed targets. Underground exploration methods in mining; Location of extension of ore deposits and dislocated ore bodies; Persistence of ore in depth; Duties of mining geologist; Preparation of mine plans; Geological report writing.

Unit II:

Mineral Exploration – its significance, necessity and objectives; Methods in mineral exploration- objectives and limitations of different methods; Stages of mineral exploration; Geological methods of surface and subsurface exploration- evaluation of outcrop, panning, trenching, pitting, drilling etc; Drilling methods used in mineral exploration; choice of drilling; Types of drill patterns and density of exploratory drilling; Exploratory mining methods; Methods in outlining the ore body; Geological modelling for mineral exploration with specific examples of Indian mineral deposits.

Unit III:

Fundamentals of geochemical prospecting; Geochemical environments, mobility and distribution in dispersion of elements in primary and secondary environments; Geochemical exploration practices in different environments glacial, desertic and tropical; Methods of geochemical exploration: lithochemical, pedochemical, biogeochemical, hydrogeochemical, atomogeochemical, geobotanical methods; Statistical analysis and interpretation of geochemical prospecting data; Designing exploration models for search of different type of mineral deposits.

Unit IV:

Geophysical methods of prospecting of metallic and non-metallic mineral deposits.

Gravity method: Principle, instrumentation, field procedure and application; Gravity field surveys; Various types of corrections applied to gravity data; Preparation of gravity anomaly maps and their interpretation.

Magnetic method: Principle, instrumentation, field procedure and application; Introduction to Aeromagnetic survey.

Electrical methods: S.P. and I.P. method; Resistivity method: Principle, instrumentation, field procedure and application.

Seismic methods: Principle, instrumentation, types, field procedure and application.

Radioactivity methods: Principle, instrumentation, field procedure and application.

Practical:

Preparation of Mine plan; Diagrammatic representation of open cast and underground mining; Preparation and interpretation of geochemical anomalies maps; Problems based on statistical analysis of data obtained in geochemical exploration.

Calculation of average assay value of ore based on sampling data from bore holes and underground mine workings; Calculation of ore reserves; Preparation of vertical sections and level plans of ore deposit from bore hole data; Preparation of grade maps of mineral deposits based on sampling data; Study of gravimeter, magnetometer and seismographs; Resistivity survey; Interpretation of underground structure on the basis of seismic data.

Books Recommended:

- Arogyaswamy, R.N.P. (1995) Courses in Mining Geology, Oxford and IBH Publishing Co., New Delhi.
- Bagchi, T.C., Sen Gupta, D.K. and Rao, S.V.L.N. (1979) Elements of Prospecting and Exploration. Kalyani Publishers, New Delhi.
- Brooks, A.R. (1972) Geobotany and Biogeochemistry in Mineral Exploration, Harper and Row.
- Chugh, C.P. (1983) Manual of Drilling Technology, Oxonian Press Pvt. Ltd.
- Chugh, C.P. (1984) Diamond Drilling, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Chugh, C.P. (1992) High Technology in Drilling and Exploration, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Chugh, C.P. (1995) Drilling Technology Handbook, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Clark, G.B. (1967) Elements of Mining, Asia Publishing House.
- Compton, R.R. (1985) Geology in the Field, John Wiley and Sons Inc.
- Dobrin, M.B. (1976) Introduction to Geophysical Prospecting, McGraw Hill.
- Hawkes, H.E. and Webb, J.S. (1980) Geochemistry in Mineral Exploration, Harper and Row.
- Howel, B.F. (1959) Introduction to Geophysical Prospecting, McGraw Hill.
- Lowrie, W. (1997) Fundamentals of Geophysics, Cambridge University Press.
- McKinstry, H.E. (1972) Mining Geology, Prentice-Hall Inc.
- Mussett, A.E. & Khan, M.A. (2000) Looking into the Earth: An Introduction to Geological Geophysics. Cambridge University Press.
- Pacal, Z. (Ed.) (1977) Geochemical Prospecting Methods, Ustrendi.
- Parasnis, D.S. (1975) Principles of Applied Geophysics, Chapman and Hall.
- Peters, W. C. (1978). Exploration and Mining Geology, John Wiley and Sons Inc.
- Ramam, P.K. (1989) Principles and Practices of Mineral Exploration, Geological Society of India, Bangalore.
- Rose, A.W., Hawkes, H.E. & Webb, J.A. (1979) Geochemistry in Mineral Exploration, Academic Press.
- Sharma, P.V. (1986) Geophysical Methods in Geology, Elsevier.
- Sharma, P.V. (1997) Environmental and Engineering Geophysics, Cambridge University Press.
- Sharma, V.P. (1999) Applied and environmental geophysics.
- Stenislave, M. (1984) Introduction to Applied Geophysics, Reidel Publ.
- Thomas, L.J. (1978) An Introduction to Mining. Methuen, Brisbane.
- Vogelsang, D. (1995) Environmental Geophysics -A Practical Guide, Springer Verlag.

E1.2 Environmental Geology and Engineering Geology

Unit I:

Components of environmental geology; Atmospheric carbon-dioxide increase and global warming; Paleo-temperature estimation from ice cores; Physical, chemical and biological domains of environment; Soil pollution; Impact of mining on environment.

Unit II:

Problems of urbanization, human population and their impact on environment; Alternative sources of energy: Solar, Wind, Tidal, Geothermal, Hydal, Nuclear; Waste disposal and related problems; Environmental legislations; Earthquake and tsunami – causes of occurrence and their impact as natural hazard; Landslide and volcanic hazards their causes and control; Coastal erosion, its causes and control.

Unit III:

Scope of geology in civil engineering and mining industry; Various stages of engineering geological investigations for civil engineering projects; Engineering properties of rocks and soils; Rock discontinuities; Physical characters of building stones, metal and concrete aggregates; Use of remote sensing in engineering geology.

Unit IV:

Geological investigations for the various engineering projects: dams, reservoirs, landslides, tunnels, highways, bridges, hydroelectric power projects, shoreline and airfield engineering; Earthquake and seismicity, seismic zones of India, aseismic design of building; Exploratory drilling: study and construction of subsurface sections based upon drilling data; Core logging: core recovery, preservation of cores, R.Q.D. analyses; Preparation and presentation of geotechnical reports.

Practical:

Environmental Geology:

Preparation of seismic zonation maps of India; Demarcation of landslide prone areas in the Himalaya; Demarcation of flood prone areas in the outline map of India; Preparation of volcanic hazard zonation map; Preparation of oceanic and atmospheric circulation maps.

Engineering Geology:

Study of engineering properties of rocks/ soil with reference to their use in engineering projects; Study of models and maps of important engineering structures; Interpretation of geological maps for various engineering geology projects; Preparation of subsurface sections based on drilling data; RQD analysis.

Books Recommended:

Environmental Geology:

Bell, F.G. (1999) Geological Hazards, Routledge, London.

Bryant, E. (1985) Natural Hazards, Cambridge Univ. Press. Keller,

E.A. (1978) Environmental Geology, Bell and Howell, USA. Lal,

D.S. (2007) Climatology, Sharda Pustak Bhawan, Allahabad.

Patwardhan, A.M. (1999) The Dynamic Earth System, Prentice Hall.

Perry, C.T. and Taylor, K.G. (2006) Environmental Sedimentology, Blackwell Publ.

Smith, K. (1992) Environmental Hazards, Routledge, London.

Subramaniam, V. (2001) Textbook in Environmental Science, Narosa International.

Valdiya, K.S. (1987) Environmental Geology – Indian Context, Tata McGraw Hill.

Engineering Geology:

Bell, F.G. (1981) Engineering properties of Soils and Rocks, Butterworths Publication, London.

Bell, F.G. (1993) Fundamentals of Engineering geology, Butterworths Publication, London.

Garg, S.K. (2009) Physical and Engineering Geology, (6th Ed.), Khanna Publishers, New Delhi.

GSI (1975) Engineering Geology Case Histories, Geological Survey of India, Misc. Publ., No. 29.

Gupte, R.B. (2002) Text Book of Engineering Geology, Vidyarthi Griha Prakashan, Pune.

Keary, P., Brooks, M. and Hill, I. (2002) An introduction to geophysical exploration, 3rd Ed., Blackwell.

Kesavulu, N.C. (2009) Textbook of engineering geology, (2nd Ed.), Macmillan Publishers India Ltd.

Krynine, D.P. and Judd, W.R. (1998) Principles of Engineering Geology and Geotechnics, CBS Publishers & Distributors, New Delhi.

Reddy, D.V. (1998) Engineering Geology for Civil Engineering, Oxford & IBH Pub.Co. Pvt. Ltd., Delhi.

Rider, M.H. (1986) The Geological Interpretation of Well Logs. (Rev. Ed.) Whittles Publishing, Caithness.

Ries, H. and Watson, T.L. (1947) Elements of Engineering Geology, 2nd Ed., John Wiley & Sons, NY.

Schultz, J.R. and Cleaves, A.B. (1951) Geology in Engineering, John Willey and Sons, New York.

Singh, P. (1994) Engineering and General Geology, S.K. Kataria and Sons, Delhi.

Telford, W.M., Geldart, L.P., Sherrif, R.E. and Keys, D.A. (1976) Applied Geophysics, Cambridge Univ. Press.

Verma, B.P. (1997). Rock Mechanics for Engineers, 3rd Ed., Khanna Publishers, New Delhi.

Wittke, Walter (1990). Rock Mechanics: Theory and Applications with case Histories, Springer – Verlag Publication.

E1.3 Petroleum Exploration

Unit I:

Introduction to Petroleum geology, types of petroliferous basins and their relation to hydrocarbon potential; Global geographic and stratigraphic distributions of oil and gas; Classification and stratigraphy of petroliferous basins of India; Estimation of oil and gas reserves and resources; Basin mapping – structure and isopach contouring, lithofacies and biofacies maps; Petrophysics- rock fluid system and interaction, reservoir characteristics, reservoir heterogeneity and drive mechanisms of carbonate and clastic reservoirs.

Unit II:

Methods and techniques for petroleum exploration, surface indications and direct detection of hydrocarbons; Geochemical methods of Petroleum exploration; Sniffer surveys; Introduction to different biomarkers used in oil exploration; Significance of major microfossil groups such as foraminifers, calcareous algae, ostracods, dinoflagellates, pollen and spores in hydrocarbon exploration; Case studies of Indian sedimentary basins; Sub-surface exploration techniques: concept of potential, magnetic, gravity and seismic methods of geophysical exploration; Seismic data acquisition, processing and interpretation; Synthetic seismograms; Gas hydrates and CBM exploration.

Unit III:

Oil well Drilling methods, drilling equipments, drilling rig - its components and functions, rig sizing and selection, drilling fluids, wellheads, casing and cementing operations, principles of kick control, fishing jobs, drill stem test (DST); Types of offshore and onshore drilling operations; Well completion;

Well logging: Formation evaluation, Archie's formulae, principles, methods and application of logging tools including Spontaneous polarization, resistivity, microresistivity, induction, sonic, density, neutron techniques, hingle, pickett, MID, M-N cross plots, saturation estimation, natural gamma ray, gamma ray spectrometry, cement bond, variable density, caliper, dipmeter, formation microscanner and imager; Well log interpretation - quick lithology, porosity and permeability determination; Log interpretation case studies.

Unit IV:

Duties of a well-site geologist; Geotechnical order (GTO), coring and core analysis; Examination of well cuttings; Preparation of lithologs and composite logs; Principles of formation testing; Development geology, production and enhanced oil recovery (EOR) methods; Principles of petroleum economics.

Practical:

Map projections of different oil horizons in Indian sedimentary basins, their stratigraphic order, and study of microfossils like foraminifers, calcareous algae, ostracods, dinoflagellates, pollen and spores in hydrocarbon exploration; Granulometric analysis, seismic facies analysis, seismic profile interpretation, preparation of different lithologs; Interpretation of different well log data from different sedimentary environment with the use of Electro-logging (SP, GR, resistivity, Neutron, Density, Dipmeter etc); Core sample studies (identifications of sedimentary structures, lithology, facies and paleoenvironment from core data); Time corrections applied to seismic data; Preparation of synthetic seismograms and calibration of well data; Laboratory analysis related to coal bed methane studies.

Books Recommended:

- Amadei, B. (1997) *Rock Stress and its Measurement*, Chapman & Hall, London.
- Baker, R.A (2001) *Primer of Oil well Drilling: A basic text of oil and gas drilling*, Petroleum Extension Service, University of Texas at Austin.
- Barwis, J.H. (1990) *Sandstone Petroleum Reservoir*, Springer-Verlag, Berlin.
- Berg, R.R. (1986) *Reservoir Sandstones*, Prentice Hall, New Jersey.
- Bhandari, L.L., Venkatachala, B.S., Kumar, R., Swamy, S.N., Garga, P. and Srivastava, D.C. (Eds.) (1983) *Petroliferous Basins of India*, Petroleum Asia Journal, Himachal Times Group.
- Biswas, S.K., Dave, A., Garg, P., Pandey, J., Maithani, A. and Thomas, N.J. (Eds.) (1993) *Proceedings of 2nd Seminar on Petroliferous Basins of India, Dehra Dun, Dec.18-20, 1991, Vol. 1, 2 and 3*, Indian Petroleum Publishers, Dehra Dun.
- Bordenave, M.L. (Ed.) (1993) *Applied Petroleum Geochemistry*, Editions Technip, Paris.
- Chilinger, G.V. and Vorabutr, P. (1981) *Drilling and Drilling Fluids*, Elsevier Science, Amsterdam.
- Deutsch, C.V. (2002) *Geostatistical Reservoir Modelling*, Oxford University Press, Oxford.
- Durable, O. (1998) *Geostatistics in Petroleum Geology*, AAPG Cont. Education Course Note Series 38.
- Asquith, G. and Gibson, C. (1982) *Basic Well Log Analysis for Geologists*, Academic Press, London.
- Goovaerts, P. (1997) *Geostatistics for Natural Resources Modelling*, Oxford University Press, Oxford.
- Guegen, Y. and Palciauskas, V. (1994) *Introduction to Physics of Rocks*, Princeton University Press.
- Gupta, P.K. and Nandi, P.K. (1995) *Well Site Geological Techniques and Formation Evaluation: A User's Manual, Vol. I*, Oil and Natural Gas Corporation, Dehra Dun.
- Hyne, N.J. (2001) *Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production*, 2nd edition, Pennwell Corporation, Tulsa, Oklahoma.
- Levenson, A.L. (1970) *Geology of Petroleum*. Freeman and Company.
- Mallet, J.L. (2002) *Geomodelling*, Oxford Univ. Press, Oxford.
- Moore, C.H. (2001) *Carbonate Reservoirs*, Elsevier, Amsterdam.
- Serra, O. (2003) *Well Logging and Geology*, Editions Technip, Paris.
- Peters, K.E., Walters, C.C. and Moldowan, J.M. (2005) *The Biomarker Guide (Vol. 1 & 2)*, Cambridge University Press, Cambridge.
- Bateman, R.M. (1985) *Open Hole Log Analysis and Formation Evaluation*, Reidel, Dordrecht.
- Ransom, R.C. (1995) *Practical Formation Evaluation*, John Wiley & Sons, New York.
- Sahay, B., Rai, A. and Ghosh, M. (1984) *Wellsite Geological Techniques for Petroleum Exploration*, Oxford & IBH, New Delhi.
- Schlumberger Manual Log Interpretation Principles/Applications, Vol. 1 & 2,
Rider, M.H. (1985) *The Geological Interpretation of Well Logs*, Blackie,
London. Schlumberger Education Services, New York, 1989.
- Selley, R.C. (1998) *Elements of Petroleum Geology*, II Edition, Academic Press.
- Serra, O. (1984) *Fundamentals of Well Log Interpretation*, Vol.1 and 2, Elsevier.
- Singh, L. (2000) *Oil and Gas Field of India*, Indian Petroleum Publishers, Dehra Dun.
- Tiab, D. and Donaldson, E.C. (1996) *Petrophysics: Theory and Practice of Measuring Reservoir Rock and Fluid Transport Properties*, Gulf Publishing Company, Houston, Texas.
- Tissot, B.P., Welte, D.H. (1984) *Petroleum Formation and Occurrence*, Springer-Verlag, Berlin. Welte, D.H., Horsfield, B., Baker, R. (Eds.) (1997) *Petroleum and Basin Evolution: Insights from Petroleum Geochemistry, Geology and Basin Modeling*, Springer-Verlag, Berlin.
- Whittaker, A. (1991) *Mud Logging Handbook*, Prentice-Hall, Englewood Cliffs.
- Yarus, J.M. and Chambers, R.L. (Ed) (1994) *Stochastic Modelling and Geostatistics, Principles, Methods and Case Studies*, AAPG Computer Applications in Geology, No 3.
- Zimmerle, W. (1995) *Petroleum Sedimentology*, Kluwer Academic Publishers, Dordrecht.

E1.4 Quaternary Geology and Limnogeology

Unit I:

Significance of Quaternary studies; Quaternary Stratigraphy; Quaternary deposits in India; Evolution of man and cultural stages; Morphostratigraphy; Criteria used for defining Pliocene- Pleistocene boundary; Pleistocene-Holocene boundary.

Unit II:

Scope of paleoclimatic studies; Sources of paleoclimate reconstruction; Quaternary Paleoclimate; Causes of ice ages and other climatic changes; Soils and paleosoils and their significance in interpreting Quaternary climates; Quaternary sea level changes; Linkage of the modern climate to past climatic variation (with special emphasis on the Holocene).

Unit III:

Geochronological methods used in dating Quaternary events: K-Ar and ^{39}Ar - ^{40}Ar dating, Radiocarbon dating (^{14}C), ^{12}C - ^{13}C dating, Thermoluminescence (TL), ^{210}Pb and ^{137}Cs Chronology; Paleomagnetic dating; Magnetic Susceptibility study and paleorainfall; Dendrochronology; Stable Oxygen isotopes and paleoclimates.

Unit IV:

Scope of Limnogeology; Major divisions of lakes; Physical, Chemical and Biological environments of lakes; Geological evolution of lake basins; Applications of the freshwater fossil Diatoms and polynomorphs in limnogeological study; Methods of investigations of lake signatures: Drought, tsunami, storm, anthropogenic metal, land use changes, earthquake; Sedimentological and geochemical archive in lake deposits; Lake sediment records of carbonaceous particles from fossil-fuel combustion and Soot Particle counting.

Practical:

Study of palaeogeographic maps of Quaternary period; Standardization of stratigraphic sequences on the basis of facies analysis. Study of sediment core of lake: Cutting, labelling and sample preparation for geochemical investigations; Preparation of smear slide: Complete layout for preparation of smear slides and examination with a wild petrographic scope; Process of maceration of lake/ river sediments to prepare diatom slides; Identification of water quality using sedimentary diatoms; Geochemical archives in lake deposits; Soot Particle counting for lake sediment dating.

Books Recommended:

Quaternary Geology:

Arnold (2002) Quaternary Environmental Micropaleontology (Ed. Simon K. Haslett), Oxford Univ. Press, New York.

Bowen, D.Q. (1978) Quaternary Geology.

Oerlemans, J. (2001) Glaciers and climate change, A.A Balkema.

Pomeroy, (1982) The Cenozoic Era: Tertiary and Quaternary, Ellis Harwood Ltd.

Soil Survey Staff (1992) Keys to soil taxonomy, Vth Edition SMSS Monograph No. 19.

Tiwari, M.P. and Mohabey, D.M. (Eds.) (1999) Quaternary of India, Gondwana Geological Magazine, Spl. Vol. 4.

Limnogeology:

Benson, L., Kashgarian, M., Rye, R., Lund, S., Paillet, F., Smoot, J., Kester, C., Mensing, S., Meko, D., and Lindström, S. (2002) Holocene multidecadal and multicentennial droughts affecting Northern California and Nevada: Quaternary Science Reviews, v. 21.

Kharaka, Y.K., Robinson, S.W., Law, L.M., and Carothers, W.W. (1984) Hydrogeochemistry of Big Soda Lake, Nevada; an alkaline meromictic desert lake: Geochimica et Cosmochimica Acta, v. 48.

Lebo, M.E., Reuter, J.E., and Meyers, P.A. (1994) Historical changes in sediments of Pyramid Lake, Nevada, USA: consequences of change in the water balance of a terminal desert lake: Journal of Paleolimnology, v.12.

Meyers, P.A., Tenzer, G.E., Lebo, M.E., and Reuter, J.E. (1998) Sedimentary record of sources and accumulation of organic matter in Pyramid Lake, Nevada, over the past 1,000 years: Limnology and Oceanography, v. 43.

Rosen, M.R., Arehart, G.B. and Lico, M.S. (2004) Exceptionally fast growth rate of <100-yr-old tufa, Big Soda Lake, Nevada: Implications for using tufa as a paleoclimate proxy: Geology, v. 32.

Russell, I.C. (1885) Geological History of Lake Lahontan, a Quaternary lake of northwestern Nevada: Washington, United States Geological Survey, 288p.

Smol, J.P., Birks, H.J.B. and Last, W.M. (2003) Tracking Environmental change using lake sediments: Terrestrial, Algal and Siliceous Indicators, Paleoenvironmental Research Book Series, 371p.

Taylor, K., Alley, R.B., Fiacco, J., Grootes, P.M., Lamorey, G.W., Mayewski, P.A. & Spencer, M.J. (1992) Ice core dating and chemistry by direct-current electrical conductivity: Journal of Glaciology, v. 38. Wetzel, R.G. Limnology of Lakes and River Ecosystem, Third Edition.

Foundation Course 1
PSCGEOT12:(1.1)INTRODUCTION TO GEOLOGY

Unit I:

Milky Way and the solar system; Modern theories on the origin of the Earth and other planetary bodies; Geological Time Scale; Space and time scales of processes in the solid Earth, atmosphere and oceans; Age of the Earth; Radioactive isotopes and their applications in earth sciences; Earth's gravity and magnetic fields and its thermal structure.

Unit II:

Gross composition and physical properties of important minerals and rocks; properties and processes responsible for mineral concentrations; nature and distribution of rocks and minerals in different units of the earth and different parts of India; Physiography of the Earth; weathering, erosion, transportation and deposition of Earth's material; formation of soil, soil erosion, degradation and conservation; Sediments and sedimentary rocks; physiographic features and river basins in India; Geological action of wind, glacier and river.

Unit III:

Basic concepts of seismology and internal structure of the Earth; Physico-chemical and seismic properties of Earth's interior; Volcanoes; Mountain building; Earthquakes – their causes and measurement; Paleomagnetism; sea floor spreading & plate tectonics; Environmental degradation, management and conservation.

Unit IV:

Hypsography of the continents and ocean floor –continental shelf, slope, rise and abyssal plains. Physical and chemical properties of sea water and their spatial variations. Residence times of elements in sea water. Ocean currents, waves and tides, important current systems, thermohaline circulation and the oceanic conveyor belt. Major water masses of the world's oceans. Biological productivity in the oceans.

Books Recommended:

Arthur Holmes (1978) Principles of Physical Geology.
Cazen, Hatcher and Siemekowski: Physical Geology.
Emmons, Thiel, Staffer and Allison: Geology principles and Processes.
Gilluly, Water and Woodward: Principles of Geology.
Hamblin, Kenneth: The Earths' Dynamic System.
Howell: Introduction to Geophysics.
Judson Kauffman and Leet: Physical Geology.
Judson, Deffeyws and Hargrave: Physical Geology. Mallory and Cargo: Physical Geology.
Manroe and Wicander: Physical Geology- Exploring the Earth Patwardhan A.M.: The Dynamic Earth System.
Robinson, E.S. (1982): Basic Physical Geology
Sanders J.E., Anderson Jr., A.Z., Carola: Physical Geology.
Sawkins, Chase, Darby and Rapp: The Evolving Earth: A Text Book in Physical Geology.
Skinner and Porter: The Dynamic Earth: An introduction to Physical Geology. Tarbuck and Lutgens: The Earth: An introduction to Physical Geology.

Foundation Course 1
PSCGEOT12:(1.2) ECONOMIC GEOLOGY

Unit I

Definition of ore, ore minerals and gangue minerals, grades of ores and non-metallic minerals, assay value and tenor of ore. Broad outline of ideas regarding classification of mineral deposits, Bateman's classification. Principles and processes of formation of mineral deposits in detail: Magmatic concentration deposits; Pegmatitic deposits; Sublimation deposits; Contact metasomatic deposits; Submarine exhalative volcanogenic deposits; Hydrothermal deposits (Cavity filling and replacement).

Unit II

Principles and processes of formation of following mineral deposits: Residual concentration deposits; Mechanical concentration deposits (Placers); Sedimentary deposits; Evaporites; Bacteriogenic deposits; Supergene sulphide enrichment deposits; Metamorphic and metamorphosed deposits with suitable Indian examples.

Unit III

Mineralogy, uses, geological occurrences, origin and geographical distribution of the mineral deposits of - Iron, Chromium, Tungsten, Tin, Lead, Zinc, Gold, Aluminium, Radioactive minerals, Natural hydrocarbons (oil and natural gas); Non-metals related to refractory, fertilizers, cement, chemical and gemstone industry like- Asbestos, Barytes, Gypsum, Mica, Graphite, Talc, Magnesite, Kyanite, Sillimanite, Monazite, Pyrite and Diamond.

Unit IV

Mineralogy, uses, geological occurrences, origin and geographical distribution in India of the following: Manganese, Copper, Fossil fuel: lignite and coal. Brief account of the geological setting and mineralization of the following: Kolar gold field, Singhbhum copper belt, Malanjkhand copper deposit, Lead zinc deposit of Zawar, Manganese belt of Maharashtra, Iron ore deposits of Bastar, Bauxite deposits of Maharashtra, Mica deposits of Bihar, and Andhra Pradesh. Gondwana coal deposits, Neyveli lignite deposit, Gypsum deposit of Rajasthan and beach placers of Kerala.

Books recommended:

Jensen and Bateman: Economic Mineral Deposits.
Sen and Guha: A Handbook of Economic Geology.
Banerjee: Mineral Resources of India.
Sharma and Ram: Introduction to India's Economic Minerals.
Deb: Industrial Minerals and Rocks of India.
Krishnaswamy: India's Mineral Resources.
Babu: Tin in India.
Babu: Diamonds in India.
Radhakrishnan and Curtis: Gold in India.
Deshpande: Geology of Maharashtra.

SYLLABUS for M. Sc. GEOLOGY
Choice Based Credit System (Semester Pattern)
GONDWANA UNIVERSITY GADCHIROLI 2017-18
M.Sc. GEOLOGY (Semester IV)

Code	Theory / Practical	Teaching Scheme (Hrs/ week)			Credits	Examination Scheme					
		Th	Pr.	Total		Duration (Hrs)	Max. Marks		Total Marks	Min. Passing Marks	
							External	Internal		Th	Pr.
Core 11	PSCGEOT13 Ore Geology and Ore Microscopy (3+1)	4		4	4	3	80	20	100	40	
Core 12	PSCGEOT14 Indian Mineral Deposits and Mineral Economics (3+1)	4		4	4	3	80	20	100	40	
Core Elective 2	PSCGEOT15 (Any one) E2.1 Fuel Geology (Coal, Petroleum & Nuclear) E2.2 Exploration Geochemistry (4) E2.3 Basin analysis and Sequence Stratigraphy (2+2) E2.4 Marine Geology and Oceanography (2+2)	4		4	4	3	80	20	100	40	
Founda- tion Course 2	PSCGEOT16 Foundation Course 2 FC-2.1 Paleobiology (or) FC-2.2 Geodesy and Mapping	4		4	4	3	80	20	100	40	
Pract. Core 7	PSGEOPO7 Ore Geology, Ore Microscopy, based on Paper 15 and Geological Field Work (Marks: 55 Pract. + 05 Viva-voce + 20 Field Work + 20 Internal Assessment and Class Record)		8	8	4	3	80	20	100		40
Project	PSCGEOP08 Project (Marks: 40 Project Evaluation + 20 Project Presentation + 20 Viva-voce + 20 Internal Assessment)		8	8	4	3	80	20	100		40
Seminar	Seminar 3	2		2	1	---		25	25	10	
Total		18	16	34	25		480	145	625	170	80

FIELD WORK:

Candidate shall attend geological excursion organized by the Department for a period of 10 to 20 days. This will include field work, visit to geologically important places, mines, geological and scientific organisations. Candidates should submit the field report at the end of excursion along with the geological specimens collected during the programme. The field work is a part of Practical 7 of Semester IV and field report will be evaluated by the field excursion in-charge.

PROJECT WORK:

Every student is required to carry out **Experimental / Field Based Project Work** (this is in lieu of practical 8 of semester IV) on a related research topic of the subject /course. On the basis of this work, student must submit the Project Report (typed and properly bound) in two copies at least one month prior to commencement of the final Practical Examination of Semester IV.

After Semester-II the candidates are required to carry out geological investigation independently approved by the Head of the Department and Project Guide. The area/ topic of the project work shall be assigned to the students at the end of Semester - II depending upon the expertise available in the Department.

The Project report shall comprise of introduction, aims and objectives, short literature review, methodology/ materials and methods, experiments and results, discussion, conclusion and references along with the declaration by the candidate that the work is original and not submitted to any University or Organization for award of the degree, and certificate by the supervisor and forwarded through Head of the Department. The project report will be essentially evaluated by two referees, which includes **Project Guide** as internal referee and one **external referee**.

The Project Work will carry total 100 marks and will be evaluated by both external and internal examiner in the Department.

For written Project work	: 40 Marks (Evaluated jointly by External & Internal)
Project presentation	: 20 marks (Evaluated jointly by External & Internal)
For Viva-Voce	: 20 Marks (Evaluated by External examiner)
Internal Assessment	: 20 Marks (Evaluated by Internal examiner)

Total	: 100 Marks

PSCGEOT13:Ore Geology and Ore Microscopy

Unit I:

Modern concept of ore genesis; Spatial and temporal distribution of ore deposits -a global perspective; Comparison between Earth's evolutionary history and evolutionary trends in ore deposits; Ore deposits and Plate Tectonics; Mode of occurrence of ore bodies -morphology and relationship of host rocks; Study of principal ore mineral groups; Paragenesis and zoning of ores and their significance; Geological thermometers; Fluid inclusion in ores: principles, assumptions, limitations and applications.

Unit II:

Concept of ore bearing fluids, their origin and migration; Wall-rock alteration; Structural, physico-chemical and stratigraphic controls of ore localization.

Petrological ore associations with Indian examples wherever feasible: Orthomagmatic ores of mafic-ultramafic association - diamonds in kimberlites, REE in carbonatites, Ti-V ores, chromite and PGE, Ni ores, Cyprus type Cu-Zn deposit.

Unit III:

Petrological ore associations with Indian examples wherever feasible: Ores of silicic igneous rocks - Kiruna type Fe-P, pegmatoids, greisens, skarns, porphyry associations, Kuroko-type Zn-Pb-Cu; Ores of sedimentary affiliation - chemical and clastic sedimentation; Stratiform and stratabound ore deposits (Sedimentary BIF, manganese, non-ferrous ores); Placers and palaeoplacers; Ores of metamorphic affiliations; Ores related to weathering and weathered surfaces - laterite, bauxite, Ni/Au laterite; Contemporary ore-forming systems (black smokers, mineralized crusts, Mn nodules).

Unit IV:

The ore microscope; preparation of polished section of ores; Physical and optical properties of ore minerals under reflected light; Quantitative measurement of reflectivity and microhardness; Microchemical techniques- etch test and microchemical elemental test; Structures and textures of ores, their interpretation and paragenesis; Application of ore microscopy in mineral dressing.

Practical:

Ore Geology:

Study of physical properties and identification of ores, non-metallic minerals, industrial rocks and minerals, gemstones and semi-precious minerals in hand specimens.

Ore Microscopy:

Description of optical properties and identification of ore minerals in polished sections under incident light and determination of paragenetic sequence; Exercises in the determination of reflectivity and microhardness of common ore minerals.

Books Recommended:

Ore Geology:

Barnes, H.L (1979) *Geochemistry of Hydrothermal Ore Deposits*, John Wiley. Craig,

J.M. and Vaughan, D.J. (1981) *Ore Petrography and Mineralogy*, John Wiley

Edwards, R. and Atkinson, K. (1986) *Ore Deposit Geology*, Chapman and Hall, London.

Evans, A.M. (2012) *Ore Geology and Industrial Minerals*. Third Edition (Reprint), Blackwell Publishing and Wiley India Pvt. Ltd.

Guilbert, J.M. and Park, Jr. C.F. (1986) *The Geology of Ore Deposits*, Freeman.

Jensen, M.L. and Bateman, A.M. (1981) Economic Mineral Deposits, John Wiley and Sons, New York.
Klemm, D.D. and Schneider, H.J. (1977) Time and Strata Bound Ore Deposits, Springer Verlag.
Mookherjee, A. (2000) Ore genesis -a Holistic Approach, Allied Publishers.
Sawkins, F.J. (1984) Metal Deposits in relation to Plate Tectonics, Springer Verlag.
Stanton, R.L. (1972) Ore Petrology, McGraw Hill.
Torling, D.H. (1981) Economic Geology and Geotectonics, Blackwell Sci. Publ. Wolf,
K.H. (1981) Hand book of Strata Bound and Stratiform Ore Deposits, Elsevier.

Ore Microscopy:

Craig, J.R. and Vaughan, D.J. (1994) Ore Microscopy and Ore Petrology, John Wiley.
Ineson, P.R. (1989) Introduction to Practical Ore Microscopy, Longman Publishers.
Picot, P. and Johan, Z. (1982) Atlas of Ore Minerals, Elsevier Publishers.
Ramdohr, P. (1969) The Ore Minerals and their Intergrowths, Pergamon Press.
Sahoo, R.K. (2011) Atlas of oxide ores of India and their textures, SSDN Publishers and Distributors, New Delhi.

PSCGEOT14: Indian Mineral Deposits and Mineral Economics

Unit I:

Study of the following Indian ore deposits with reference to their mineralogy, mode of occurrence, origin, geological association and geographical distribution: Iron, manganese, gold, aluminium, chromium, copper, lead and zinc.

Unit II:

Study of the following Indian ore deposits with reference to their mineralogy, mode of occurrence, origin, geological association and geographical distribution: Tin, tungsten, titanium, nickel and molybdenum; Minerals used in metallurgical, refractory and abrasive industries.

Unit III:

Study of the following mineral deposits with reference to their mineralogy, mode of occurrence, origin, geological association and geographical distribution in India: Minerals used in ceramics, cosmetic, glass, fertilizers, cement, chemical, paints and pigments, electrical and gemstone industries.

Unit IV:

Concept of mineral economics; Significance of minerals in National economy; Use of various minerals in industries; Production and its effect on prices of minerals; Demand and supply, their effect on prices; International aspects of mineral industries; Cartels and their influence on mineral industry; Mineral resources in India and their present status and future development; Strategic, critical and essential minerals; Conservation and substitution of minerals; Mines and mineral legislation in India, Mineral development fund; Law of sea bed for marine mineral resources; United Nations Framework Classification (UNFC); National Mineral Policy; Statistical modelling for the future requirements and production levels of minerals in India.

Books Recommended:

Indian Mineral Deposits:

Babu, T.M. (1994) Tin in India, Geological Society of India, Bangalore.

Babu, T.M. (1998) Diamonds in India, Geological Society of India, Bangalore.

Banerjee, D.K. (1992) Mineral Resources of India, The World Press Pvt. Ltd., Kolkata

Deb, S. (1980) Industrial Minerals and Rocks of India, Allied Publishers, New Delhi.

Karant, R.V. (2000) Gems and Gem Industry in India, Geological Society of India, Bangalore.

Krishnaswamy, S. (1979) India's Mineral Resources, Oxford and IBH, New Delhi.

Radhakrishnan, B.P. and Curtis, L.C. (1999) Gold in India, Geological Society of India, Bangalore.

Sharma, N.L. and Ram, K.S.V. (1964) Introduction to India's Economic Minerals, Dhanbad Publishers.

Mineral Economics:

Chatterjee, K.K. (1993) An Introduction to Mineral Economics, Wiley Eastern.

Sinha, R.K. and Sharma, N.L. (1993) An Introduction to Mineral Economics, Wiley Eastern

PSGEOT15:Core Elective 2

E2.1 Fuel Geology (Coal, Petroleum and Nuclear)

Unit I:

Origin of coal; Sedimentology of coal bearing strata; Structures associated with coal seams; Proximate and Ultimate analysis of coal; Rank, grades and types of coal; Indian and International classification for coking and non-coking coals; Coal preparation: coal carbonization, coal gasification, underground coal gasification (UCG), coal hydrogenation and coal combustion.

Unit II:

Coal Petrology – concept of 'lithotype', 'maceral' and 'microlithotype'; Classification and optical properties of macerals and microlithotypes; Techniques and methods of coal microscopy; Reflectance and fluorescence microscopy; Application of coal petrology for different industrial purposes; Geological and geographical distribution of coal and lignite deposits in India; Coal exploration and estimation of coal reserves; Indian coal reserves and production of coal in India; Coal Bed Methane (CBM); Generation, retention and exploration of methane from coal beds.

Unit III:

Petroleum: Different states, natural occurrences, chemical composition and physical properties of different fractions; Origin of Petroleum: Transformation of organic matter into kerogen, organic maturation, thermal cracking of kerogen; Migration of oil and gas; Reservoir rocks: General attributes and petrophysical properties; Classification of reservoir rocks- fragmental reservoir rocks and chemical reservoir rocks; Reservoir fluids- water, oil and gas; Hydrocarbon traps: Structural, stratigraphic and combination traps; Cap rock: Definition and general properties; Petroliferous basins of India; Elements of petroleum exploration; Hydrocarbons: Present status and future prospects.

Unit IV:

Mineralogy and geochemistry of radioactive minerals; Mode of occurrence, origin, association and distribution of atomic minerals in nature (U, Th, Be, rare metals and REE etc); Atomic minerals as source of energy; Metallogenic epochs and provinces of uranium mineralisation; Principles and methods of exploration for radioactive mineral deposits; Radiometric surveys: Methods of detection and measurement of radioactivity; Geiger Muller Counters and Scintillation Counters; Gamma ray logging of bore holes; Application of radioactivity in geochronometry; Uranium and thorium exploration in India; Productive geological horizons in India; Atomic fuels and environment; Nuclear power stations of India and future prospects.

Practical:

Macroscopic characterization of banded coals; Completion of outcrop in the given maps and calculation of coal reserve; Preparation of polished particulate mounts of coal; Microscopic examination of polished particulate mounts (identification of macerals); Proximate analysis of coal; Laboratory analysis related to coal bed methane studies.

Study of geological maps and sections of important oil fields of India; Calculation of petroleum reserves; Problems on classification of oil field water based on chemical composition.

Megascope identification of common minerals used in atomic industry.

Books Recommended:**Coal Geology**

Acharyya, S.K. (2000) Coal and Lignite Resources of India: An overview, Geological Society of India, Bangalore.

Chandra, D., Singh, R.M. and Singh, M.P. (2000) Textbook of Coal (Indian Context), Tara Book Agency, Varanasi.

Francis, W. (1961) Coal, Edward Arnold Ltd.

Scott, A.C. (1987) Coal and Coal-bearing strata: Recent Advances, Blackwell Scientific Publications.

Singh, M.P. (Ed.) (1998) Coal and Organic Petrology, Hindustan Publ. Corp., New Delhi.

Stach, E. et al. (1975) Stach's textbook of coal petrology, Berlin: Gebruder Borntraeger.

Stach, E., Mackowsky, M.T.H., Taylor G.H., Ghandra, D., Telchmuller, M. and Telchmuller, R. (1982) Stach's Text Book of Coal Petrology, Gebruder Borntraeger, Stuttgart.

Taylor, G.H., Teichmüller, M. and Davis, C. (1998) Organic Petrology: A new handbook incorporating some revised parts of Stach's Textbook of Coal Petrology.

Taylor, G.H., Teichmuller, M., Davis, A., Diessel, G.F.K., Littke, R. and Robert, P. (1998) Organic Petrology, Gebruder Borntraeger, Stuttgart.

Thomas, Larry (2002) Coal Geology, John Wiley and Sons Ltd., England.

Van Krevelen, D.W. (1993) Coal: Typology-Physics-Chemistry-Constitution, Elsevier Science, Netherlands.

Petroleum Geology:

Holson, G.D. and Tiratsoo, E.N. (1985) Introduction to Petroleum Geology, Gulf Publ. Houston, Texas. Levenson, A.L. (1970) Geology of Petroleum, Freeman and Company.

North, F.K. (1985) Petroleum Geology, Allen and Unwin.

Selley, R.G. (1998) Elements of Petroleum Geology, Academic Press.

Tissot, B.P. and Welte, D.H. (1984) Petroleum Formation and Occurrence, Springer- Verlag.

Nuclear Geology:

Aswathanarayana, U. (1985) Principles of Nuclear Geology, Oxford Press.

Boyle, R.W. (1982) Geochemical Prospecting for Thorium and Uranium Deposits, Elsevier.

Dahlkamp, F.J. (1993) Uranium Ore Deposits, Springer Verlag.

Durrance, E.M. (1986) Radioactivity in Geology, Principles and Application, Ellis Horwood.

E2.2 Exploration Geochemistry

Unit I:

Geochemistry in mineral exploration: Brief history and present status; Geochemical cycle; Geochemical environments, mobility and distribution of major, minor and trace elements and secondary environment; Anomalies and background values; Indicator elements; Primary dispersion: related patterns, haloes.

Unit II:

Secondary dispersion and accumulation of elements, weathering, formation of soil, secondary dispersion patterns, haloes and geochemical anomalies in soils, residual overburden, bed rocks, over blind ore bodies, over transported overburden and in waters and plants; Geochemical, metallogenic and biogeochemical provinces; Vegetation anomaly; Precision and accuracy.

Unit III:

Interpretation of geochemical anomalies including pathfinders and preparation of different geochemical maps and treatment of geochemical data; Geochemical techniques in exploration: lithogeochemical, pedogeochemical, hydrogeochemical, biogeochemical, atmogeochemical and stream sediment surveys; Regional and detailed surveys.

Unit IV:

Biochemical, geobotanical and geozoological prospecting; Application of remote sensing in geobotanical exploration; Selected case histories of geochemical exploration of Copper, Lead, Zinc, Nickel and Chromium; Geochemical aspects of geothermal resources; Area selection and sequential exploration model; Geochemical conceptual models.

Practical:

Preparation and interpretation of geochemical anomaly maps using probability graphs; Problems based on analysis of data obtained in geochemical exploration; Geochemical modelling problems.

Books Recommended:

Govett, G.J.S. (1983) Rock Geochemistry in mineral exploration, Vol.3, Elsevier Scientific Publishing Company.

Govett, W.K., Hoffman, S.J., Merthens, M.B., Sinclair, A.J. and Thomson, I. (1987) Exploration Geochemistry, Design and Interpretation of Soil Survey, Reviews in Economic Geology, Vol.4.

Hale, M. and Plant, J.A. (1994) Handbook of Exploration Geochemistry – Drainage Geochemistry, vol 6, Elsevier Scientific Publishing Company.

Levinson, A.A. (1974) Introduction to Exploration Geochemistry, Applied Publishing Ltd. USA.

Reedman, J.H. (1979) Techniques in mineral exploration. Applied Science Publishers.

Rose, Arthur W., Herbert, E. Hawkes and Webb, John S. (1979) Geochemistry in Mineral Exploration; 2nd edition, Academic Press.

Solov, A.P. (1987) Geochemical Prospecting; Mir Publishers, Moscow.

E2.3 Basin analysis and Sequence Stratigraphy

Unit I:

Concept of basin analysis; Tectonic classification and geothermal evolution of sedimentary basins; Allogenic and autogenic controls on sedimentation, modes of sediments transport sedimentary facies and facies models with Indian analogues; Paleocurrent analysis and sediment dispersal patterns; Quaternary sedimentology.

Unit II:

Processes and characteristics of depositional environments such as fluvial, estuarine, deltaic, lagoonal, barrier beach, tidal flats and deep-sea environments; Flysch and molasse; Sedimentation and plate tectonics.

Unit III:

Sequence stratigraphy, its concept and evolution; Order and duration of sequences; Application and significance of sequence Stratigraphy; Fundamentals of sequence stratigraphy, depositional sequence, sequence architecture, types and boundaries, condensation and starvation; Conformity and types of sequence unconformities; Flooding surface, maximum flooding surface, marine flooding surface; Bed, bedset, parasequence, parasequence boundary, para-sequence set, regional unconformities.

Unit IV:

Lowstand system tract, transgressive system tract, transgressive surface and highstand system tract, overlap, offlap, toplap and onlap, aggradation, progradation, retrogradation, transgression and regression; Eustatic sea level changes, sediment supply, basin subsidence rate, and accommodation. Outcrop, subsurface and offshore sequence stratigraphy and their integration; Seismic stratigraphy; Sequence stratigraphy in well sections and application of well logs; Sequence stratigraphic approach in basin analysis with Indian examples.

Practical:

Paleocurrent analysis; Preparation of facies maps and facies diagrams; Study of vertical profile sections of some selected sedimentary environments; Study of significant system tracts.

Books Recommended:

Basin Analysis:

Allen P. A. and Allen, J.R.L. (2005) Basin Analysis: Principles and Application, Blackwell Publishers.

Miall, A.D. (2000) Principles of Basin Analysis, Springer-Verlag.

Perry, C.T. and Taylor, K.G. (2006) Environmental Sedimentology, Blackwell Publishers, U.K.

Reading, H.G. (1996) Sedimentary Environments and facies, Blackwell Scientific Publishers.

Reineck, H.E. and Singh, I.B. (1978) Depositional Sedimentary Environments, Springer-Verlag.

Sequence Stratigraphy:

Boggs, S. (2001) Principles of Sedimentology and Stratigraphy, Prentice Hall.

Coe, Angela, Dan Bosence, Kevin Church, Steve Flint, John Howell and Chris Wilson (2002): The Sedimentary Record of Sea Level Change, Cambridge Univ. Press.
Emery, D, (1996) Sequence Stratigraphy, Blackwell Scientific Publ.
Miall, A.D. (1997) The Geology of Stratigraphic Sequence, Springer-Verlag.
Reineck, H.E., and Singh, I.B. (1980) Depositional Sedimentary Environments, Springer-Verlag.
Vail, P.R., Mitchum, R.M., Todd, R.G., Widmier, J.M., Thompson, S., Sangree, J.B., Bubb, J.N. and Hatlelid, W.G. (1977) Seismic stratigraphy and global changes of sea level: American Association of petroleum Geologists, Vol.26.

E2.4 Marine Geology and Oceanography

Unit I:

History of development of marine geology; Origin of ocean basins; A brief account of tectonic history of the oceans; Oceanic crust; Deep ocean-floor topography; Morphology of ocean margins; Marine sediments, sources and composition, sediment types and distribution; Oceanic sediments and microfossils; Deep sea sediments and their relation to oceanic processes such as productivity, solution and dilution.

Unit II:

Oceanic circulation - Surface, intermediate and deep ocean circulation; Forces that produce and effect circulation patterns in world oceans; Important phenomena associated with surface circulation; Formation and movement of deep and bottom waters; Sedimentation rates; Calcite and aragonite compensation depth.

Unit III

Methods and instruments for exploring the ocean floor; Deep Sea Drilling Project (DSDP), Ocean Drilling Programme (ODP) and Joint Global Flux Studies (JGOFS) and their major accomplishments; Integrated Ocean Drilling Programme (IODP) and its aims and objectives; Sediment distribution in time and space as related to tectonic models; Marine stratigraphy, correlation and chronology; Deep sea hiatuses and their causes; Approaches to paleoceanographic and paleoclimatic reconstructions; Paleoceanographic changes in relation to earth system history including impact of the oceans on climate change.

Unit IV:

Evolution of oceans through the Cenozoic; Ocean gateways and their role in controlling global climates; Sea level changes during Quaternary with special reference to India; Reconstructing Quaternary climatic and oceanographic history on shorter time scales using marine records; Mineral resources of the ocean including polymetallic nodules; Hydrocarbons beneath the sea floor; Marine gas hydrates and their economic potential; Marine pollution and interpreting marine pollution with the help of microfossils.

Practical:

Sedimentary facies; Bio facies; Depth biotopes and estimation of paleodepth of the ocean using benthic foraminiferal assemblages; Identification of modern and ancient surface water mass with the help of planktic foraminiferal assemblages; Identification of benthic foraminifera characteristic of Low oxygen environment; Identification of planktic foraminifera characteristic of warm and mixed

layer, thermocline and deep surface water of the modern oceans; Study of modern surface water, mass assemblages of planktic foraminifera from Indian ocean, Atlantic ocean and Pacific ocean.

Books Recommended:

Kennett, J.P. (1982) Laboratory Exercises in Oceanography Marine Geology, Prentice Hall. Seibold, E. and Berger, W.H. (1982) The Sea Floor, Springer-Verlag.

**PSGEOT16:Foundation Course 2
(FC 2.1)Paleobiology**

Unit I

Concept of species, evolution and extinction; Theories about origin of life; Types of fossils, Processes of fossilization; Modes of preservation of organisms; Index fossil and their significance.

Unit II

Diagnostic morphological characters and significance of Brachiopoda, Mollusca (Bivalvia, Gastropoda and Cephalopoda); Brief idea about ichno-fossils and their significance.

Unit III

Basic ideas about micropalaeontology and types of microfossils based on composition; Micropaleontology in petroleum exploration; Diagnostic morphological characters and geological significance of Foraminifera, Calcareous algae, Diatoms and Palynomorphs.

Unit IV

Diagnostic morphological characters and geological significance: Echinoidea and Trilobita; Gondwana flora; Vertebrate life through ages; Indian dinosaurs and causes of their extinction.

Books recommended:

Clarkson: Invertebrate Palaeontology and evolution.

Swinnerton: Fossils.

Shrock and Twenhofel: Principles of Palaeontology.

Woods: Invertebrate Palaeontology.

Moore, Lalicker and Fisher: Invertebrate fossils

Stearn and Carroll: Palaeontology the record of Life.

Arnold: An introduction to Palaeobotany.

Black: Elements of Invertebrate Palaeontology.

Koregave: Fundamentals of Invertebrate Palaeontology.

PSGEOT16: Foundation Course 2
FC-2.2 Geodesy and Mapping

Unit I:

Principles of surveying methods; Instrumental methods used in geological mapping and mineral surveys and their usefulness in different conditions; Types of mineral deposit surveys, instruments used-prismatic compass, Brunton compass, theodolite, and plane table with alidade; Method of survey, recording the readings and plotting the traverse, triangulation and establishment of horizontal control points.

Unit II

:Leveling and contouring : Instruments for leveling -hand level, Abney level, Dumpy level, automatic level; Methods of leveling-spot leveling, differential leveling, profile leveling and trigonometric leveling; Plane table survey with telescopic alidade and its use in detailed geological mapping; Astronomical observation of true N-S and latitude.

Unit III:

Fundamentals of mine surveys, surveys in open cast mines and underground mines; Geological mapping in open cast and underground mines.

Unit IV:

Objectives of Geological mapping, precision required in geological mapping; Topographic maps and base maps for geological mapping, topographic maps and their numbering by Survey of India; Types of geological maps and sections; Geological symbols in maps; General principles of geological mapping; Mapping methods in sedimentary, igneous and metamorphic terrains.

Books Recommended:

- Bomford, B.G. (1971) Geodesy, Oxford.
- Clark, D. (1962) Plane and Geodetic Surveying (Volume I and II) Asia Publishing House. Compton, R.R. (1962) Manual of Field Geology, John Wiley and Sons, Inc. Forrester, J.D. (1957) Principles of Field Geology and Mining Geology, John Wiley.
- Hosmer, G.L. (1946) Geodesy, Wiley.
- Kanetkar, T.P. and Kulkarni, S.V. (1990) Surveying and Leveling (Vol. I and II), Pune Vidyarthi Griha Prakashan, Pune.
- Kissam, P. (1956) Surveying Instruments and Methods for Survey of Limited Extent. McGraw Hill.
- Lahi, F.H. (1987) Field Geology, CBS Publishers.
- Mathur, S.M. (2001) Guide to Field Geology, Prentice-Hall, New Delhi