M.Sc. PETROLEUM GEOSCIENCES SYLLABUS

The intake shall be limited to ten seats through the B. H. U. Entrance Test. Students having passed Three Year and/or Six Semester B.Sc. (Hons.) Geology from Banaras Hindu University or any other equivalent examination of other universities with Physics and Mathematics at **+2** level shall be considered eligible for appearing at the Entrance Test. In view of the course being customized to the requirements of the hydrocarbon industry, the Department proposes to run the course subject to the concurrence of the University as fully self financed with a fee structure of Rs. 50,000/- per semester.

The M.Sc. Petroleum Geosciences shall be imparted to students for two academic sessions consisting of four semesters as given below. Candidates will be examined and evaluated on grade basis at the end of each semester in the different courses of theory and practical as per credits given against each course. The M.Sc. Petroleum Geosciences will consist of (a) Core Courses, (b) Minor Elective Courses of other Departments, (c) Industrial Training at oil companies (4-6 weeks) and (d) Project Oriented Dissertation (periodic seminars, final presentation and thesis).

a) The Core courses will be compulsory for all the students admitted to M.Sc. Petroleum Geosciences. There will be thirteen core courses, covering major branches of Geosciences, seven practicals, two seminar and viva-voce.

b) M.Sc. Petroleum Geosciences incorporates two compulsory minor elective courses of other Departments, one each in semester-II and III and each of 2 credits.

c) The industrial training includes four to six weeks training at oil companies of 8 credits in semester IV. Besides, there will be one 'inter semester winter geological field training in hydrocarbon prospective basin' in semester-I and one 'inter semester summer geological field training in hydrocarbon producing basin' in semester-II, each of 1.5 credits.

d) Along with the above courses, there shall be a Project Oriented Dissertation of 12 credits in semester-IV.

Marks for theory and practical examinations shall be as under:

Exam. Components	Marks for Semester Exam.	**Sessional** Intra Semester Test + class assignment and regularity	**Sessional** Intra-semester practical assessment + class assignment and regularity	Total Marks
Theory	70	30 (20+10)	-	100
Practical	70	-	30 (20+10)	100

M. Sc. Petroleum Geosciences Syllabus

(Effective from 2012-13)

SEMESTER – I

Course Code	Title	Credits
PGM 101	Structural Geology and Tectonics	3
PGM 102	Sedimentology	3
PGM 103	Applicative Palaeontology and Stratigraphy	3
PGM 104	Fundamentals of Petroleum Geology	3
PGM 105	Seminar and Viva-Voce	2
PGM 106	Practicals connected with PGM 101	1.5
PGM 107	Practicals connected with PGM 102	1.5
PGM 108	Practicals connected with PGM 103	1.5
	Inter semester winter Geological Field Training in hydrocarbon pospective basin-I	1.5
	Total	**20**

SEMESTER – II

Course Code	Title	Credits
PGM 201	Seismic Data Acquisition, Processing and Petrophysics	3
PGM 202	Geophysical Exploration and Basin Analysis	3
PGM 203	Hydrocarbon Geochemistry	3
PGM 204	Sequence Stratigraphy	1.5
PGM 205	Reservoir Study	3
PGM 206	Practicals connected with PGM 201 & PGM 202	1.5
PGM 207	Practicals connected with PGM 203 & PGM 204	1.5
PGM 208	Inter semester **summer** Geological Field Training in hydrocarbon pospective basin-II	1.5
	Minor Elective (from other PG Programmes); PGM 209:Minor Elective (for other PG Programmes)	2
	Total	**20**

SEMESTER – III

Course Code	Title	Credits
PGM 301	Well Site Geological Techniques	3
PGM 302	Drilling and Production	3
PGM 303	Economics, Policy and Managements	3
PGM 304	Non-conventional Petroleum Exploration	3
PGM 305	Seminar and Viva Voce	3
PGM 306	Practicals connected with PGM 301 & PGM 302	1.5
PGM 307	Practicals connected with PGM 304	1.5
#	Minor Elective (from other PG Programmes); PGM 308; Minor Elective (for other PG Programmes)	2
	Total	**20**

SEMESTER – IV

Course Code	Title	Credits
PGM 401	Industrial Training at Oil Companies	8
PGM 402	Project Oriented Dissertation	12
	Total	**20**
	Grand Total	**80**

M. Sc. Petroleum Geosciences students will opt 2 Minor Electives (2 credit each in semester II & III) offered by other PG programmes of Faculty.

SEMESTER - I

Course No. PGM 101: STRUCTURAL GEOLOGY AND TECTONICS

THEORY **Credits: 3**

Mechanical Principles and properties of rock. Factors controlling deformational behaviour of rocks. Concepts of stress and strain; translation, rotation, and deformation, kinematic and dynamic analysis, description of folds, joints, unconformities and salt domes, mechanisms of the above structures; Cleavage, lineation and foliation, Stereographic projections of linear and planar structures, maps and cross sections; Mohr's diagram for stress representation. Failure envelop; Theories of rock failure. Dynamics of faulting, Frictional sliding laws and fault movement mechanisms. Structural association of normal, reverse and strike slip faults, Recognition of faults from isopach and structure contour maps. Concepts of thin skinned tectonics and of balanced cross section. Principle geotectonic features of ocean, continents and continental margins. Concept of plate tectonics; force balance and plume models for plate motion. Features of the plate margins.

Books Recommended:

Condie, Kent. C. (1982): Plate Tectonics and Crustal Evolution, Pergamon Press Inc.
Gass I.G. (1982): Understanding the Earth. Artemis Press (Pvt) Ltd. U.K.
Ghosh, S.K. (1993): Structural Geology: Fundamental and Modern Developments. Pergamon Press.
Hobbs, B.E., Means, W.D. and Williams, P.F. (1976): An outline of Structural Geology, John Wiley and Sons, New York.
Ramsay, J.G. (1967): Folding and fracturing of rocks, McGraw Hill.
Ramsay, J.G. and Huber, M.I. (1983): Techniques of Modern Structural Geology, Vol. I, Strain Analysis, Academic Press.
Ramsay, J.G. and Huber, M.I. (1987): Techniques of Modern Structural Geology, Vol. II, Folds and Fractures, Academic Press.
Ramsay, J.G. and Huber, M.I. (2000): Techniques of Modern Structural Geology, Vol. III (Application of continuum mechanics), Academic Press.
Turner, F.J. and Weiss, L.E. (1963): Structural analysis of Metamorphic Tectonites, McGraw Hill.
Windlley B. (1973): The Evolving continents, John Wiley and Sons, New York.

Course No. PGM 102: SEDIMENTOLOGY

THEORY **Credits: 3**

Principles and applications of Sedimentology in Petroleum Geoscience; Texture - shape, size, fabric and surface textures, methods of textural analysis, textural parameters and their significance.
Petrogesis of sandstones, Graywacke and graywacke problem; plate - tectonics and sandstones composition; Argillaceous rocks, their classification and genesis.
Limestones and dolomites, their petrographic characteristics and models of dolomitization; Study of evaporites such as gypsum, anhydrite and halite; Detailed study of siliceous and phosphatic rocks; Diagenesis - physical and chemical, processes and evidences of diagenesis in sandstones and carbonate rocks.
Fluid flow mechanics and formation of sedimentary bedforms; Details of paleocurrent analysis; Implication of facies in environmental interpretation of different continental and marine environments with emphasis on coastal and shallow marine systems.

Books Recommended:

Blatt, H., Middleton, G.V. and Murray, R.C. (1980): Origin of Sedimentary Rocks, Prentice-Hall Inc.
Collins, J.D., and Thompson, D.B. (1982): Sedimentary Structures, George Allen and Unwin, London.

Lindholm, R.C. (1987) A Practical Approach to Sedimentology, Allen and Unwin, London.
Miall, A.D. (2000): Principles of Basin Analysis, Sjpringer-Verlag.
Pettijohn;, F.J. (1975): Sedimentary Rocks (3rd Ed.), Harper and Row Publ., New Delhi.
Reading, H.G. (1997): Sedimentary Environments and facies, Blackwell Scientific Publication.
Reineck, H.E. and Singh, I.B. (1973): Depositional Sedimentary Environments, Springer-Verlag.
Selley, R. C. (2000) Applied Sedimentology, Academic Press.
Tucker, M.E. (1981): Sedimentary Petrology: An Introduction, Wiley and Sons, New York.
Tucker, M.E. (1990): Carbonate Sedimentolgy, Blackwell Scientific Publication.

Course No. PGM 103: APPLICATIVE PALAEONTOLOGY AND STRATIGRAPHY

THEORY **Credits: 3**

Palaeontology – scopes, branches and applications to biostratigraphy, palaeoecology, palaeoichnology & taphonomy; Diagnostic morphological features of some important mega invertebrates. Types of microfossils; description and uses of selected groups of microfossils: - foraminifera, ostracods, diatoms, nannoplanktons, cocoliths, spores and pollens.

Basic principles of stratigraphy, international code of stratigraphic nomenclature, stratigraphic classification, , correlation. Stratigraphy of Vindhyan supergroup; Gondwana Supergruop; Jurassic of Kuchchh and Rajasthan; Cenozoic of Assam; Kachchh & Andman Nicobar Islands.

Books Recommended:

Bignot, G., Grahm and Trottman (1985): Elements of Micropalaeontoogy, London.
Boardman, R.S., Cheethan, A.M. and Rowell, A.J. (1988): Fossil Invertebrates, Blackwell.
Boggs, S. (2001): Principles of Sedimentology and Stratigraphy, Prentice Hall.
Clarksons, E.N.K. (1998): Invertebrate Paleontology and Evolution, Allen and Unwin, London.
Doyle, P. and Bennett. M.R. (1996): Unlocking the stratigraphic Record, John Wiley and Sons.
Krishnan,M.S. (1982): Geology of India and Burma, C.B.S. Publ.
Kumar, R. (1985): Historical Geology and Stratigraphy of India, Wiley Eastern Ltd.
Lehmann, U. (1983): Fossils Invertebrate, Cambridge Univ. Press.
Moore, R.C., Lalicker, C.G. and Fischer, A.G.(1997): Invertebrate Fossils, CBS Publ.
Pascoe, E.H. (1968): A Manual of the Geology of India and Burma (Vols.I-IV), Govt. of India Press, Delhi.
Prothero, D.R. (2004): Bringing Fossil to Life – An Introduction to Palaeontology (2nd Ed.), McGraw Hill.
Raup, D.M. and Stanley, S.M. (1985): Principles of Palaeontology, CBS Publ..
Schoch, Robert, M. (1989): Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York.

Course No. PGM-104: FUNDAMENTALS OF PETROLEUM GEOLOGY

THEORY **Credit: 3**

Introduction. Origin of Petroleum (Inorganic and Organic theories). Generation, migration and accumulation of oil and gas. Concept of petroleum system. Reservoir rocks (clastic and non-clastic reservoir rocks, development and types of porosity in these rocks. Controls of permeability). Petroleum traps. Cap rocks (seals). Occurrence, surface indications and direct detection of hydrocarbons. Petroleum habitats. An outline of the oil belts of the world.

Books Recommended:

Barker, C. (1996): ThermalModeling of Petroleum Generation, Elsevier Science.
Holson, G.D. and Tiratso, E.N. (1985): Introduction of Petroleum Geology, Fulf Publ. Houston.
Hunt, J.M. (1996): Petroleum geochemistry and geology (2nd Ed.), Freeman, San Francisco.
Jahn, F., Cook, M. and Graham, M.(1998):Hydrocarbon Exploration and Production, Eslevier Science.
Makhous, M. (2000): The Formation of Hydrocarbon Deposits in North African Basins, Geological and Geochemical Conditions, Springer–Verlag.
North, F.K. (1985): Petroleum Geology, Allen Unwin.
Selley, R.C. (1998): Elements of petroleum geology, Academic Press.

Tissot, B.P. and Welte, D.H. (1984): Petroleum formation and occurrence, Springer–Verlag.

Course No. PGM-105: SEMINAR AND VIVA-VOCE **Credit: 2**

Course No. PGM 106: Practicals connected with PGM 101 **Credits: 1.5**

Preparation and interpretation of geological maps and sections, structural problems based on orthographic and stereographic projections of linear and planar structures; Recording and plotting of field data; Study of the hand specimen of deformed structures, preparation of geotectonic maps.

Course No. PGM 107: Practicals Connected with PGM 102 **Credits: 1.5**

Detailed study of clastic and non-clastic rocks in hand specimens; Study of assemblages of sedimentary structures in context of their paleoenvironmental significance; Microscopic examination of important rock-types; Heavy mineral separation, their microscopic characters, graphic representation and interpretation; Grain-size analysis by sieving method; Plotting of size-distribution data as frequency and cumulative curves, computation of statistical parameters and interpretation.

Course No. PGM 108: Practicals Connected with PGM 103 **Credits: 1.5**

Study of the morphological characters of some important invertebrate fossils belonging to Brachiopoda, Bivalvia, Gastropoda, Ammonoidea, Trilobita, Echinoidea and Corals; Study of an assorted group of trace fossils; Techniques of separation of microfossils from matrix; Study of larger benthic foraminifera with special reference to Cenozoic petroliferous basins of India; Important palynomorphs of Cretaceous and Palaeogene age; Study of rocks in hand specimens from known Indian stratigraphic horizons and type localities.

Course No. PGM-109: INTER SEMESTER WINTER GEOLOGICAL FIELD TRAINING IN HYDROCARBON PERSPECTIVE BASIN-I **Credit: 1.5**

SEMESTER - II

Course No. PGM 201: SEISMIC DATA ACQUISITION, PROCESSING AND PETROPHYSICS

THEORY **Credits: 3**

Historical development and background refraction and reflection methods. Difference between refraction and reflection surveys. System of observations for reflection and refraction surveys. Refraction data interpretation for two horizontal and dipping layer case. Sources of seismic energy, Noise analysis, elevation weathering and dynamic corrections. Processing of seismic data, Migration techniques (classical and modern), Pitfalls of seismic interpretations. Interpretation of geology from data, VSP data acquisition, processing and utilization concepts, Petro-physical properties of rocks.

Course No. PGM 202: GEOPHYSICAL EXPLORATION AND BASIN ANALYSIS

THEORY **Credits: 3**

Seismic velocity in rocks and methods of its determination. Preparation of depth map from time horizons. Basic concepts, definitions and objective of seismic stratigraphy, seismic attributes analysis, seismic sequence analysis – interpretation of depositional environment and lithology, seismic facies analysis, seismic reflection character analusis, Introduction to 3 D volume based interpretation.
Theory of gravity and magnetic exploration methods. Introduction to electromagnetic methods.

Books recommended:

Introduction to Geophysical prospecting, Milton B. Dobrin & Carl H. Savit.
Applied Geophysics, Telford, R.E. Sheriff & D.A. Keys.
Yillmez, O. (200); Seismic data analysis: Processing inversion and interpretation of seismic data (vol. 1, and Vol. 2), SEG, Tulsa, Oklahoma.
Amade B (1997): Rock stress and its measurement, chanmpman and Hall. London.
Hardage B.A. (1987) Seismic Stratigraphy.
Sheriff R.E. and Geldart L.P. (1995): Exploration Seismology (2nd Edition) Cambridge University Press.

Course No. PGM 203: HYDROCARBON GEOCHEMISTRY

THEORY **Credits: 3**

Carbon cycle, origin composition and structure of organic matter, organic matter accumulation, maturation process and generation of hydrocarbons (oil and natural gas); Optical and geochemical methods for source rock characterization and maturation assessment; Coals, oil shales and other terrestrial source rocks for hydrocarbon generation; Modeling petroleum generations, migration and accumulation; Abnormal pressures; Soil analysis of surface seepages of oil and gas and surface geochemical exploration, Geochemical programme for petroleum exploration; Biomarkers and source rock-oil correlation, oil-oil correlation using biomarkers; Petroleum system; Prospect evaluation.

Books Recommended:

Bordenave, M.L. (Ed.) (1993): Applied Petroleum Geochemistry, Editions Technip, Paris.
Peters, K.E., Walters, C.C., Moldowan, J .M. (2005): The Biomarker Guide (Vol.1 and 2), Cambridge Univ. Press.
S. A. Tedesco (1994): Surface Geochemistry in Petroleum Exploration, Springer-Verlag.
Tissot, B.P., Welte, D. H. (1984.): Petroleum Formation and Occurrence, Springer-Verlag.
Welte, D.H., Horsfield, B., Baker, R. (1997): Petroleum and Basin Evolution: Insights from Petroleum Geochemistry, Geology and Basin Modeling, Springer-Verlag.

Course No. PGM 204: SEQUENCE STRATIGRAPHY

THEORY **Credits: 1.5**

Sequence stratigraphy, its concept, evolution, order and duration, application and significance; 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; System tracts - 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; 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 and case history of important petroliferous basins of India.

Books Recommended:

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, Blachwell Scientific Publ.

Miall, A.D. (1997): The Geology of Stratigraphic Sequence, Springer-Verlag.

Catuneanu, O. (2006): Principles of Sequence Stratigraphy, Elsevier.

Course No. PGM 205: RESERVOIR STUDY

THEORY **Credits: 3**

Carbonate reservoirs, deep water sandstones (turbidites) reservoirs, sandstone reservoirs, reservoir fluids, phase behaviour, reservoir pressure measurement and its significance, reservoir drive mechanisms; Concept of surface tension, wet ability, capillary, oil, water and gas saturations, fluid displacement etc; Calculation of reservoir parameters from well logs; Estimation of hydrocarbon reserves, classification of reserves; Development of oil and gas field. Recovery of hydrocarbon; Enhanced oil recovery / improved oil recovery; Reservoir management, well test analysis and pressure transient studies, bore holes studies and their importance.

Books Recommended:

Berg, R.R. (1986): Reservoir Sandstones, Prentice Hall.

Moore, C. H. (2001): Carbonate Reservoirs, Elsevier, Amsterdam.

Barwis, J.H. (1990): Sandstone Petroleum Reservoir, Springer-Verlag.

Zimmerle, W. (1995): Petroleum Sedimentology, Kluwer Academic Publ.

Course No. PGM 206: Practicals connected with PGM 201 and PGM 202. **Credits: 1.5**

Determination of the depth of horizontal bed rock from T.D. curve and also dip of the bed by reverse refraction survey. Study of seismic maps, preparation of time maps and depth maps. Calculation of the travel time in VSP and its derivations for the deviation of the well towards the source. Drawing of neat diagram showing the principle of NMO calculation and depth determination of reflector. Identification and correlation of seismic markers. Calculation of interval velocity in a geological formation.

Course No. PGM 207: Practicals connected with PGM 203 & PGM 204 **Credits: 1.5**

Megascopic and microscopic study of cores; Preparation of geological maps and sections, and derivation of geological history in relation to petroleum prospects; Calculation of oil reserves; Exercise on maturation studies; Petrographic characterization of petroleum source rocks.

Identification of sequence boundaries. Study of the important Mesozoic basins in light of sequence stratigraphic analysis.

Course No. PGM 208: INTER SEMESTER SUMMER GEOLOGICAL FIELD TRAINING IN HYDROCARBON PRODUCING **BASIN-II** **Credits: 1.5**

Course No.: MINOR ELECTIVES (From other PG Programmes) **Credits: 2**

Course No :PGM 209. **Conventional Petroleum System** Credits: 2

(Minor Elective for other PG)

Carbon Cycle .Petroleum system elements, source rocks (origin , composition and structure of organic matter), Kerogen, organic maturation , thermal cracking of kerogen leading to generation of hydrocarbons. Migration of petroleum. Accumulation of petroleum and reservoir rocks. Rreservoir traps. Cap rocks.

SEMESTER - III

Course No. PGM 301: WELL SITE GEOLOGICAL TECHNIQUES

THEORY **Credits: 3**

Introduction, status of wells, geotechnical order, drilling methods, drilling fluids, cutting and core analysis, mud logging unit, sub-surface pressures, electro-logging (sp. gr. resistivity, neutron-density, dipmeter, etc); Formation evaluation; Casing and cementation, drilling completions, formation testing, well completion, fundamental of reservoir, engineering and stimulation, documentation; Off-shore technology.

Books Recommended:

Asquith, G. and Gibson, C. (1982): Basic Well Log Analysis for Geologists, Academic Press.

Bateman, R. M. (1985): Open Hole Log Analysis and Formation Evaluation, Reidel, Dordrecht.

Gupta, P. K. and Nandi, P. K. (1995): Wellsite Geological Techniques and Formation Evaluation: A user's manual, Vol. Oil and Natural Gas Corporation, Dehradun.

Ransom, R.C. (1995): Practical Formation Evaluation, John Wiley and Sons.

Rider, M.H. (1985): The Geological Interpretation of Well Logs, Blackie, London.

Sera, O. (1984): Fundamentals of Well Log Interpretation, Vol. 1 and 2, Elsevier, Amsterdam.

Serra, O. (2003): Well Logging and Geology, Editions Technique Paris.

Whittaker, A. (1991): Mud Logging Handbook, Prentice Hall.

Course No. PGM 302: DRILLING AND PRODUCTION

THEORY **Credits: 3**

Drilling methods with special emphasis on directional and horizontal methods; monitoring of drilling wells.

Well Planning: Objective, input data for well planning, Geotechnical order; Casing point selection: Casing setting Depth Criteria, methodology of casing seat selection; Casing Design: Casing types and their function, casing specification, Factors affecting casing design, design criteria.

Drilling bits: Classification & selection, Geologic considerations in producing operations, reservoir considerations in well completion, well testing, primary cementing, well completion design, tubing strings, packers, surface control equipment, perforating oil and gas wells; Well completion and work over fluids. problem well analysis, through tubing production logging, squeeze cementing – remedial cementing, sand control, formation damage, surfactants for well treatments, acidizing, hydraulic fracturing, scale deposition, removal and prevention, corrosion control, work over jobs and work over planning.

Books Recommended:

Baker, R. (2001): A Primer of Oil Preparation of SP and Resistivity Logs for Hydrocarbon Reservoirs, Well Drilling: A basic text of oil and gas drilling, petroleum extension service, University of Texa.
Chilinger, G.V. and Vorabutr, P. (1981): Drilling and Drilling Fluids. Elsevier Science.
Hyne, N.J. (2001): Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production (2nd Ed.), Pennwell Co., Oklahoma.
Nguyen, J.P. (1996): Drilling, Editions Technique, Paris.

Course No. PGM 303: ECONOMICS, POLICY AND MANGEMENT

THEORY **Credit: 3**

Management, nature, scope and purpose. Organization concept and significance, formal and informal organizations, organizational structure, manpower resources, communication, team management, ethical decision making, concepts of managerial economics.

Micro economics, macro economics, fundamental principal of managerial economics, opportunity cost principle, marginal principal, discounting principal, concept of time perspective, inflation, national income.

Accounting concepts: Business entity, money measurement, going concern, materiality and realization, accounting conventions: Consistency, full disclosure, conservatism and materiality. Capital expenditure. Methods of evaluating capital budget proposals. Zero base budgeting.

New exploration licensing policies (NELP), implementation of NELP – speculative surveys, review/reassessment study of fields including reserves, preparation of data packages. Basic ideas of bidding, etc., monitoring of blocks, approvals/review – development plans, appraisal programme, annual work programme and budgets (be and re) monitoring of safety and environment aspects under PSC– regular safety and environment audits and their compliance are carried out for companies operating under production sharing contract, ISO certification, project management process; project risk management, quality management in projects.

Books Recommended:

- Koontz Harold and Weihrich Heinz: Essentials of Management, Tata. Mcgraw Hill.
- T.S. Grewal: Introduction to Accounting.
- Gupta G.S.: Managerial Economics, Tata. Mcgraw Hill.
- Carlo Danl (2004): International Energy Markets: understanding pricing, policies and forfits, Pennwell Co.
- D. Johnston (2003): International Exploration Economics, Risk and contract Analysis, Pennwell Co.
- Ian Lerche and James A. Mackay (1999): Economics Risks in Hydrocarbon Exploration, Pennwell Co.
- Jim Bush and Daniel Johnston (2003): International Oil Company Financial Management in Non-technical language, Pennwell Co.
- John Orban (2006): Money in the Ground, Meridian Press.
- Lawrence J. Drew (1997): Undiscovered Petroleum and Mineral Resources: Assessment and Controversy, Plenum Press.

- P. M. Harris and L.J. Weber (2006): Giant Hydrocarbon Reservoirs of the world, AAPG Memoir no. 88.
- R.Hannessom (2001): Investing for Sustainability: The management of mineral wealth, Springer-Verlag.
- Richard Barry (1993): The Management of International Oil Operations, Pennwell Co.
- T. Aven and J.E., Vinnem (2007): Risk Management with Application from the Offshore Petroleum Industry, Springer-Verlag

Course No. PGM 304: NON-CONVENTIONAL PETROLEUM EXPLORATION

THEORY **Credits: 3**

Coal system analysis. Origin of coal. Physical, optical and chemical characterization of coal. Coal bed methane – definition, origin of coal bed methane, geological controls of methane generation from coal, Global coal bed methane potential and reserves. CBM exploration and exploitation, environmental problem – water quality and utilization, CBM policy and regulations. Underground coal gasification - definition, concept, development of UCG, implications of burning UCG, estimation of coal reserves for UCG, environmental benefits of UCG, global potential areas, UCG process, advantages, policy on UCG; Gas hydrates - definition, structures, compositions, world occurrences, exploration methods, potential locations on Indian off-shores, environmental impacts and future prospects. Fundamentals of Shale gas and Basin centered gas. Importance of oil Shales as a resource.

Books Recommended:

Chandra, D., Singh, R.M. Singh, M. P. (2000): Textbook of Coal (Indian context), Tara Book Agency.

Gayer,R. and Harris, I. (1996): Coal Bed Methane and Coal Geology, Geological Soc. Special Publ., London.

Singh, M.P. (Ed.) (1998): Coal and Organic Petrology, Hindustan Publ. Co.

Stach;, E., Mackowsky, M-Th., Taylor, G.H., Chandra, D., Teichumullelr, M. and Teichmuller R.(1982): Stach Texbook of Coal Petrology, Gebruder Borntraeger, Stuttgart.

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

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

Van Krevelen, D. W. (1993): Coal (typology-physics-chemistry-constitution), Elsevier Science.

Course No. : PGM 305- Seminar and Viva-Voce **Credits: 3**

Course No. PGM 306: Practicals connected with PGM 301 & PGM 302 **Credits: 1.5**

Study of drill cores; Preparation and interpretation of SP, resistivity and other logs for hydrocarbon reservoirs; Exercise on formation evaluation.

Course No. PGM 307: Practicals connected with PGM 304 **Credits: 1.5**

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).

Course No.: MINOR ELECTIVES (From other PG Programmes) **Credits: 2**

Course No.PGM 308: Basin Analysis (Minor Elective for other PG) **Credits: 2**

Concept of basin analysis. Tectonic classification of sedimentary basins. Processes and characteristics of depositional environments such as fluvial, estuarine, deltaic, and deep-sea environments. Applications and importance of Quaternary sedimentology.

SEMESTER – IV

Course No. PGM 401: INDUSTRIAL TRAINING AT OIL COMPANIES (4-6 WEEKS).

Credits: 08

Course No. PGM 402: PROJECT ORIENTED DISSERTATION **Credits: 12**

This includes periodic seminars, final presentations and thesis.