DELTA STUDIES INSTITUTE
ANDHRA UNIVERSITY
MODIFIED SYLLABUS FOR M.TECH. PETROLEUM EXPLORATION

I SEMESTER

PES 101: GLOBAL PETROLEUM SCENARIO AND SEDIMENTARY BASINS OF INDIA.

Unit 1:

Types of energy - global and national energy scenario-future trends in energy supply and demand. Geographical distribution pattern of hydrocarbon reserves and their impact on global politics.
An over view of energy resources:

(i) Non-renewable – coal, oil, natural gas, and Nuclear energy.
(ii) Renewable – Solar, wind, hydel, ocean (thermal / wave / tidal) and geothermal energy, and
(iii) Non-conventional oil and gas – oil shales, tar sands, tight gas sands, shale gas, coal bed methane (CBM) and gas (methane) hydrates.

Future energy demands in India and action plans to meet them.

Unit 2:

Sedimentary basins -origin and classification. Types of basins and their relationship to hydrocarbon prospects. Basin location and Crustal evolutions of sedimentary basins, Geosynclinal Basins, plate tectonic theories, tectonic framework and classification of phenerozoic sedimentary basins of India

Unit 3:

Tectonic classification, stratigraphic evolution and hydrocarbon accumulations in the following basins of India
Cambay basin and Gulf of Cambay, Mumbai offshore, Cauvery basin, Krishna-Godavari basin, and Mahanadi and Mahanadi Offshore

Unit 4:

Hydrocarbon accumulations and stratigraphy of the following sedimentary basins:
Upper Assam, Naga Hills, Tripura, Cachar-Manipur, and Rajasthan basin.

Unit 5:

Prospective sedimentary basins of India:

Bengal including offshore, Kutch Saurastra including offshore, Punjab-Ganga valley, Gondwana basins.
Andaman and Nicobar Basins with intermediate prospects, Sub Himalayan Basins, Kerala –Laccadive, Vindhyan basin.

Suggested Books

1. Beck, R.J. 2004. Worldwide petroleum industry outlook-2004-2008, Projection to 2013, 20th Edn., Pennwel Corp Inc., Tulsa, Oklahoma.
2. Mougone, G.J (ed.), 1979. Energy policies of the world. Vo. III, India, Japan, Taiwan, Elsevier Pub Co.
3. Petroleum Exploration and production activities, India - 2005-2006. Published by Directorate General of Hydrocarbons (DGH), Government of India.
4. Hepple, P (ed). 1970. Petroleum supply and demand. Elsevier Pub., Amsterdam.
5. Lakshman Singh, 2000, Oil and gas fields in India, Indian Petroleum Publishers, Dehradun.
6. Bhandari, L.L., Venkatachala, B.S., Kumar, R., Swami, S.N., Garga, P. and Srivastava, D.C. (Eds.), 1983. Petroliferous basins of India. Special Volume, Petroleum Asia Journal, Vol. VI, No. 4, Himachal Times India (Pub.).
7. Biswas, S. K., Dave, A; Garg, P; Pandey, J; Maithane, A.. and Thomas, N.J. (eds.); Proceedings of 2nd seminar on Petroliferous basins of India (1991), Vol. 1&2 (1993), Vol. 3 (1994), Indian Petroleum Publishers, Dehradun.
8. Einsele, G. 1991. Sedimentary basins, evolution, facies and sediment budget, 2nd Edn., Springer-Verlag, Berlin.
9. Welte, D.H., Horsefield, B and Baker, D.R. 1997. Petroleum and Basin Evolution, Springer-Verlag, Berlin.
10. Busby, C. J. and Ingersoll, R. V., 1995. Tectonics of sedimentary basins, Blackwell Science, Oxford.
11. Fisher, A.C. and Judson, S (Eds.), 1975. Petroleum and global tectonics, Prince University Press. U.K.
12. S.M. Naqvi, 2005. Geology and evolution of Indian plate, Capital Publishing Company, New Delhi.

PES 102: PETROLEUM GEOLOGY

Unit – 1: Geological Methods - Field Mapping

Essential elements that control origin and occurrence of petroleum.
Location of areas, setting of base camp- Reconnaissance survey of the area, Geological mapping and Traversing. Measurement of the strike, dip and apparent thickness of the outcrops. Data plotting, compilation and interpretation of subsurface geology. Preparation of litho stratigraphic columns, litho stratigraphic correlation, geological cross sections and structure contour maps – Application of Remote Sensing techniques in Hydrocarbon exploration.

Unit – 2: Source Rocks

Definition of source rock.: Organic rich sediments as source rocks. Nature and type of source rocks - Claystone / shale. The process of diagenesis, catagenesis and metagenesis

in the formation of source rocks. Evaluation of petroleum source rock potential. Limestones as source rocks.
Coring in claystone/shales for source rock evaluation. Subsurface pressure temperature conditions for the generation of oil and gas from the source sediments. Oil window.

Unit – 3: Reservoir Rocks

Characteristics of Reservoir rocks – classification and nomenclature:
Clastic Reservoir Rocks, Carbonate Reservoir Rocks, Unconventional, fractured and miscellaneous reservoir rocks. Marine and non marine reservoir rocks.
Reservoir pore space - porosity – primary and secondary porosity, Effective porosity, fracture porosity - permeability – effective and relative permeability - Effects of diagenesis on reservoir quality, reservoir continuity- Relationship between porosity, permeability and texture.
Classification and origin of pore space – Recrystallisation – Dolomitization phenomenon – Cementation and compaction – Artificial or man made porosity and permeability.
Cap rocks: Definition and characteristics of 'cap Rocks'.

Unit – 4: Hydrocarbon migration

Geological framework of migration and accumulation. The concept of hydrocarbon migration from source beds to the carrier beds - Carrier beds to the reservoir - Free-path ways for migration - Short distance and long distance migration - Evidence for migration – oil and gas seepages.
The concept of buoyancy, capillary pressure and wettability in the process of migration of hydrocarbons – Tilted oil water contacts – Spill point.
Primary and secondary migration- Migration and accumulation of hydrocarbons – Lateral migration and vertical migration – Factors effecting primary and secondary migration – Time of accumulation.

Unit – 5: Entrapment of hydrocarbons

Mechanics of entrapment of hydrocarbons - Traps in the path of migration, entrapment and accumulation of hydrocarbons - Classification and types of traps: Structural, stratigraphic and combination type of traps- Genesis of various types of Traps – The anticlinal theory – traps caused by folding – Traps caused by faulting – Traps caused by fracturing.
Primary Stratigraphic Traps – Lenses and facies in chemical rocks – Porous carbonate facies – Organic reefs – Modern reefs – Fossil reefs – Productive reefs – Secondary stratigraphic traps – Salt domes – Origin of salt domes – Traps associated with salt domes.

Texts / Reference Books

1. Hobson, J.D. and Tirastoo, E.N. 1975. Introduction to Petroleum Geology, Scientific Pub; Becons Field.
2. Levorsen, A.I. Geology of Petroleum, 1967, 2nd Edn. W.H. Freeman C. San Francisco.
3. Hunt, J.M., Petroleum Geochemistry and Geology, 1996, 2nd Edn. W. H. Freeman, San Francisco.

4. North, F.K., 1990. Petroleum Geology, Unwin Hyman (Pub.), Boston, USA.
5. Richard, C. Selley, 1998. Elements of Petroleum Geology, Academic Press, London.
6. Chapman, R.E. Petroleum Geology. 1983, Developments in Petroleum Science, Ser. 16, Elsevier, Amsterdam.
7. G.D.Hobson (Ed.). Developments in Petroleum Geology, Vol. I, 1997, Vol. II 1980, Applied Science Publishers, London.
8. Dickkers, A.J. 1985. Geology in Petroleum Production, Development in Petroleum Science – 20, Elsevier Pub., Amsterdam.
9. Welte, D.H. Harsfield, B. and Baker, D.R. 1997. (Eds.). Petroleum and Basin Evolution, Springer-Verlag, Berlin.
10. Guillemot, J. 1991. Elements of Geology – Oil and gas exploration techniques. Technip Pub., Paris.
11. Lahee, F.H. 2002. Field Geology, 16th Edn., CBS Publishers, New Delhi.
12. John Barnes. 2003. Basic geological mapping. John Wiley, London.

PES 103: PETROLEUM GEOCHEMISTRY

Unit – 1

Composition and characteristics of liquid and gaseous Petroleum Hydrocarbons – normal, branched and isoalkanes, aromatics, asphaltenes, resins and compounds containing hetero (S,N,O) atoms. Physical and chemical properties of oils – Carbon Preference Index (CPI). API gravity, viscosity, pour point, cloud point and flash point. Classification of oils.
Oil field waters and their classification. Definitions and characteristics of some oil field waters – Meteoric water, interstitial water, connate water and diagenetic water. Their occurrence and origin. Interactions with source rocks and oil reservoirs. Importance of oil field brines in Petroleum Exploration. Role of oil field brines in the degradation of oils.

Unit – 2

Theories on the origin of petroleum – biogenic (organic) and abiogenic (inorganic) theory. Relative merits and limitations. Duplex theory combining the salient features of both the theories.
Coal bed methane – coalification process, Generation of methane in coal beds. Optimum conditions for methane generation – Nature and type of organic matter, Nature of coal, and geological conditions of deposition. Retention / liberation of methane on / from coal beds. Present status of CBM in India.

Unit – 3

Role of organic geochemistry in Petroleum Exploration. Hydrocarbon Generation in Sedimentary Rocks – Burrial of Organic Matter and its Preservation; Genesis of Petroleum. Diagenesis, Catagenesis and Metagenesis processes and their Significance. Kerogen – its composition and conversion to bitumen, Petroleum and Natural Gas. Biogenic and Thermogenic origin of methane and their distinction.
Methods for measurement of maturity of kerogen – optical (Thermal Alteration Index, Vitrinite Reflectance), Microscopic Organic Analysis (MOA) and Physico-Chemical (Fluorescence Spectroscopy, Electron Spin Resonance) Methods. Relative merits and limitations of the methods.

Unit – 4

Basic concepts of bitumen analysis – Sample collection and purity. Analytical scheme for separation of saturated hydrocarbons and their estimation by Gas Chromatography (GC) and GC coupled with mass spectrometry (GC-MS). Estimation of hydrocarbons in source rocks by Rock-Eval method and its applications.
Time-temperature index (TTI) and its correlation to important stages of oil and gas generation; Applications of TTI to petroleum exploration. The concept of LOM (level of organic metamorphism) and its importance in identification of oil and gas windows in sedimentary basins.
Correlation of several geo-chemical techniques for evolving the criteria of a potential petroleum source rock.

Unit – 5

Role of biomarkers such as pristane and phytane, porphyrines, typical compounds of steranes (sitostane, stegmastane, chlolestanes, mono and triaromatic steroids etc.), Hopanes / triterpanes (oleane, Gammacerane, moretane etc.) as indicators of depositional environments, age and maturity of source rocks.
Study of oil – oil and oil source rock correlations using physical, chemical properties, stable isotopes and biomarkers.

Suggested Books

1. Douglas Waples, 1984. Organic geochemistry for exploration geologists, Berger Pub. Minnesta USA,.
2. Richard, C. Selley, 1998. Elements of petroleum geology, Academic Press, London.
3. North, F.K., 1990. Petroleum Geology, Unwin Hyman (Pub.), Boston, USA.
4. Nagy, B and Colombo, V. 1967. Fundamental aspects of petroleum geochemistry, Elsevier Pub., Amsterdam.
5. Collins, A.J., 1975. Geochemistry of oil field waters, Elsevier Pub., Amsterdam.
6. Hunt, J.M., 1979. Petroleum Geochemistry and Geology, Freeman, San Francisco, USA.
7. Donaldson, E.C., Chilingarium, G.V. and Yen, T.F. (eds.). 1985. Enhanced oil recovery Vol.1: Developments in petroleum science, 17A. Elsevier Pub. Amsterdam,. Chapter II: Origin, composition and properties of petroleum.
8. Low, B.E. and Rice, D.D. (eds.). 1993. Composition and origin of coal bed gases. American Association of petroleum geology (AAPG) studies in Geology, Vol. 38, pp. 159-184.
9. Hobson, G.D. (ed.), 1997. Development in Petroleum Geology Vol.1. Applied Science Pub., London, Chapter II. Application of organic geochemical studies in oil and gas exploration.
10. Hobson, G.D. (ed.), 1980. Developments in petroleum geology, Vol.2: Applied Science Pub., London, Chapter IV: Oil Field Brines.
11. Tedesco, S.A.,1993 Surface Geochemistry in Petroleum Exploration, Chapman and Hall Pub., USA.
12. Tissot, B.P. and Welte, D.H. 1984. Petroleum formation and occurrence, 2nd Edn., Springer-Verlog, Berlin.

13. Waples, D.W. 1985. Geochemistry in petroleum exploration, IHRDC, Boston.
14. Chilingar, G.V., Buryakovsky, L.A., Eremenkd, N.A. and Gorfunkel, M.V. 2005. Geology and geochemistry of an oil and gas, Elsevier Pub., Amsterdam.

PES 104: GEOPHYSICAL METHODS OF EXPLORATION

Unit 1: Introduction

An overview of geophysical methods of exploration; classification – major /minor; artificial / natural; applications and limitations, need for integrated surveys.
Physical properties, rocks-density, susceptibility, resistivity and elastic wave velocities, factors controlling the properties, numerical values for important rock types, concept of physical property contrast.
Role of geophysics in understanding the internal structure of the earth and plate tectonics.

Unit 2: Gravity Methods

Earth's gravity field, origin, variation with elevation and depth, temporal and transient variations, international gravity formula, geoid, spheroid.
Principle of gravity exploration, concept of gravity anomaly; gravimeters, gravity surveys, reduction of data, free air, Bougrer and topographic correlations; concepts of regional and residuals; contamination and derivative maps.
Quantitative interpretation of anomaly maps, identification of faults, folds and contacts, principles of quantitative interpretation with reference to spheres, cylinders and thin horizontal sheets; concepts of modeling and inversion.

Unit 3: Magnetic Methods

Earth's magnetic field, origin; magnetic elements, interrelationships, transient and temporal variations; IGRF; principle of magnetic method, origin of anomalies, induced and remanant magnetizations; magnetometers, proton precession and fluxgate; plan of magnetic surveys, reduction of data; anomaly maps, identification of structures; familiarization of magnetic anomalies over spheres, sheets and dykes; interpretation of magnetic anomalies of sheets and dykes.
Airborne magnetometry, plan of surveying and presentation of results.

Unit 4: Electrical and Electromagnetic Methods

Self potential method, origin of SP; resistivity method, concept of apparent resistivity, Werner, Schlumberger and Dipole-dipole configurations; electrical sounding, interpretation through curve matching, electrical profiling; elements of electromagnetic methods, in phase, out of phase components, identification of conductors from EM anomalies.
Telluric and magneto methods, application in oil exploration.

Unit 5: Seismic Methods

Elastic propagation in rocks, Hooke's Law, acoustic impedance; Snell's Law, principles of seismic refraction method, travel time curves over horizontal interfaces and faults,

interpretation of results; principles of seismic reflection method, travel time curves, over horizontal and dipping layers, interpretation; concept of RMS interval and average velocities; seismic data acquisition on land and sea, sub-bottom profilers, seismic sources, air gun, etc., processing of seismic reflection data, single channel and multi channel seismic data interpretation methods, pitfalls, seismic stratigraphy, velocity pull ups, bright spots etc.,
Technological advances in seismic data processing, modern survey techniques; GPS; reservoir characterization.

Suggested Books

1. M.B.R.Rao, (1993). Outlines of geophysical prospecting, English Book Depo, Dehradun.
2. Radhakrishna Murthy, I.V., (1998). Gravity and magnetic interpretation in exploration geophysics. Geol. Soc. India, Bangalore.
3. Jhon, Milsom (2003). Field Geophysics, 3rd Edn. John Wiley, London.
4. Dobrin, M.B. and Savit, C.H. (1988). Introduction to geophysical prospecting, 4th Edn., McGraw Hill, New York.
5. Saha, J. G. Seismic data processing manual, ONGC Pub. Dehradun.
6. Coffeen, J.A. 1986. Seismic exploration fundamentals and seismic techniques for finding oil, 2nd Edn. Pennwell Pub. Co., Tulsa, Oklahoma.
7. Domenico, S.N. 1983. Modern Seismic Exploration concepts. Tulsa, Oklahoma.
8. Macquillin, R. Bacon, M.(eds). 1984. An introduction to seismic interpretation, reflection seismics in petroleum exploration, Grahmam, Trotman.

PES -105: DRILLING TECHNOLOGY AND WELL SITE GEOLOGY

Unit 1: Drilling Technology

Types of wells – Exploration, appraisal and development, deviated hole, horizontal and multilateral wells. Well design and casing policy.
Types and structure of drilling rigs and Rig components. Drilling tubulars and bits, Offshore rigs-for shallow and deep waters, Borehole profile and environment.
Drilling methods, predrill operations in onland and offshore environments, planning and execution of drilling operations.

Unit 2: Drilling Fluids

Types of drilling fluids, properties and functions,
Fluid influx studies and identification by Gas chromatography,
Drilling fluid circulation loop. Types of oil well cements, slurry designing and cementation.

Unit 3: Well Site Geology

Geotechnical order-anticipated geological sequences, well cutting analysis and redefining assumed lithological boundaries, drill stem testing.
Bore hole data acquisition, side wall cores-wireline formation, fluid testing

Unit 4: Drilling Hazards and Management

Mud loss and lost circulation, well kicks and blowouts, stuck pipes and liquidation, side tracking wells, Health and safety aspects in drilling.

Unit 5: Well Completion

Multiple casings-sizes-depths of landing, primary cementing and assessment of the quality of cementation, secondary cementation for repair jobs, perforation and testing of the promising horizons.

Suggested Books

1. Turaga, S.P., 2006. Drilling Fluids, their composition, function and properties, Centre for Rural Development and Environmental Studies (Pub.), Secunderabad.
2. Turaga, S.P, 2005. An introduction to oil well cement its properties, functions and slurry design techniques for trainees in an oil industry.
3. Gray, G.R. and Darley, H.C.H, 1981. Composition and properties of oil wel drilling fluids. Gulf Pub. Co., Huston.
4. McCray, A.W. and Cole, F.W. 1977. Oil well drilling technology, The English Book Depot, Dehradun.
5. Bais, P.S. 1994. Drilling operations manual. Institute of Drilling Technology, ONGC, Dehradun.
6. Gupta, P.K. and Nandi, P.K. 1994. Well site geological techniques and formation evaluation – "A user manual", Vol. 1, Exploration business group, ONGC, Dehradun.
7. Rev, B. 1996. Well site geology – Reference guide, Baker Hughes InteQ, Huston.
8. Navarro, A. 1994. Environmentally safe drilling practices, Pennwell Pub. Co., Tulsa, Oklahoma.
9. Sahay, B. Rai, A. and Ghosh, M.K. 1991. Well site geological techniques for petroleum exploration, Oxford – IBH, New Delhi.
10. Craft, B.C. Holden, W.R. and Graves, E.D. (Jr.). 1962. Well design, drilling and production, Printice Hall, New Jersey.

PES 106 (PRACTICAL): GEOLOGICAL METHODS OF EXPLORATION

Location of observed outcrops on the Toposheet.
Carrying out traversing
Measuring strike, Dip and apparent thickness of the outcrops. Computation of true thickness of outcrops.
Carrying out sampling of the outcrops for petrological, palynological and palentological studies.
Preparation of the geological map of the area, structure contour maps and isopach maps for different stratigraphic levels.
Preparation of structural contour map and location of Oil Water Contact (OWC)
Interpretation of isopach map and depositional model
Interpretation of structure contour map.

PES 107 (PRACTICAL): GEOCHEMICAL METHODS OF EXPLORATION

Evaluation of Organic matter (kerogen) type and maturity of source rocks.

i. Construction of Tissot diagram and evaluation of kerogen macerals types.
ii. Thermal maturity regions of source rocks in sedimentary basins.
iii. Identification of depth regions for potential oil or gas generation in source rocks and evaluation of their genetic potential.

Computation of Oil – oil correlations

i. Identification of genetic relationship of two oils.
ii. Identification of a oil spill source from among several neighbouring oil wells.

Computation of Oil – source rock correlations

i. Identification of nature and origin of bitumen of source rock in a drill core sample.
ii. Identification of genetic relationship of oil in one well with the rock strata (bitumen) of a same or different well.

Estimation of total organic carbon in a source rock sample by TOC Analyser.

Estimation of the following typical major and minor elements in sedimentary rocks by inductively coupled plasma spectrometer (ICP).

Si, Al, Ti, Fe, Mn, Ca, Mg, B, (Th & U)

Estimation of Na, K, Ca and Li in sediments by a flamephotometer.

Estimation of total dissolved salts in oil field brines by TDS meter.

Determination of pH and Eh of different types of water-fresh, saline water and oil field brine by a pH meter, and construction of a pH-Eh diagrams delineating the stability regions of different waters.

Study of source rock maturity and genetic potential by Rock –Eval Method.

PES 108 (Practical): GEOPHYSICAL METHODS OF EXPLORATION

Calculation of the height of an object from gravimeter observations at different levels.

Calculation of the gravity values for different latitudes.

Variation of gravity with distance from the object.

Reduction of gravity data applying drift, free air, Bouger and normal corrections.

Gravity anomaly sections for different geometric bodies like a) Sphere or Horizontal Cylinder, b) Vertical Cylinder, C) Horizontal slab, d) Vertical Prism and e) Rectangular Prism. Calculation of the maximum gravity anomaly for each model.

Calculation of magnetic elements for a given magnetic latitude.

Estimation of the magnitude and direction of induced magnetism of a rock for a given susceptibility.

Calculation of total field anomaly from given vertical and horizontal components and magnetic inclination.

Interpertation of Magnetic anomalies for different geological structures like a) anticline, b) dipping dyke, c) sloping surface, d) sphere, e) vertical dyke, f) wide dyke, all for different directions of the earth's total field

Estimation of subsurface layers from Wenner and Schlumberger configurations of resistivity surveys.

Identification of subsurface sedimentary layers and acoustic basement from a given high resolution seismic reflection section.

Estimation of thickness of different sedimentary units from observed two-way travel times.

Demarcation of acoustic basement and anomalous features like buried channels, salt domes, gas seepages, etc. from a given seismic reflection record.

PES 109 (PRACTICAL): DRILLING TECHNOLOGY AND

WELL SITE GEOLOGY

Preparation of GTO
Well construction and design.
Plotting of lithology and drilling time (litholog).
Calculation of lag time.
Study of drill cutting samples, conventional cores and side wall cores for lithology.
Plotting of inclinometer data and computation of vertical shortening and horizontal drift.
Identification of pay horizons through well site geological analysis.
Calculation of cement slurry volumes.
Determination of porosity of a sediment core sample

II SEMESTER

PES 201: WELL LOGGING AND FORMATION EVALUATION

Unit 1: Concepts of Well Logging and Evaluation

Major components of a logging unit. Log presentation - log head- scales. Drilling fluids. Invasion profile. Bore-hole environment. Environmental corrections. Petrophysical parameters. Reservoir parameters. Formation Factor. Water Saturation. Derivation of related empirical equations. Tools design and specifications. Log Quality control: Tool responses and base calibrations-Field calibrations-Log header information-Accuracy of depths and depth scales-Depth matching between various logs-Log repeats for small section or against abnormal responses.

Unit 2: Open Hole Logging Tools

Measurement of resistivities: Nonfocussed logs:- Normal- Lateral-Microlateral and Micro normal -Focussed logs:- Induction – Latero – Microlatero, Self potential log – Computation of formation water resistivity . Caliper-Inclinometer-Thermometer. Porosity tools: Borehole Compensated Sonic-Borehole Compensated Density - Borehole Compensated Neutron. Natural Gamma ray log – Spectral Gamma ray log. Sidewall coring. Wireline Formation Tester. Combination tools with reduced lengths and flexible joints- Wireline Rotary Coring tools.

Unit 3: Cased-Hole Equipment

Natural gamma ray-neutron gamma ray- casing collar locator. Cement Bond tool, Neutron Activation Logs. Perforation techniques : Shaped charges- Conventional and through tubing- Tubing conveyed. Free Point Locator-Back off operations-Pipe severing /cutting. Guidelines for log suites in exploratory and development wells. Qualitative and quantitative Interpretation of cased-hole logs.

Unit 4: Log Interpretation and Formation Evaluation

Responses of resistivity and porosity logs. Oil water contacts – Gas oil contacts. Empirical relations, determination of lithology from cross plots. Porosity and permeability estimation from logs. Gross, net and effective pay thicknesses of formations from composite logs.

Use of well logs in detecting over pressured zones. Detection and evaluation of fractured reservoirs. Shale volume estimation from different logs. Shale effect on porosity and matrix. Volumetric model of shaly formations containing hydrocarbons. Elemental analysis from Spectral Gamma Ray and ECS logs. Interpretation in clean, shaly and complex formations.

Unit 5: Well Log Applications and Advanced Tools

Measurement while drilling –Logging while drilling –Array Sonic tool- Array Induction Log - Nuclear Magnetic Resonance log. Dipmeter: Definitions- Principle- Picking up depth differences of microresistivity logs across the dipping bed plane-Computing dip angle and strike by standard nomograms or computers –Other concepts like Formation Micro Imaging by electrical conductivity and acoustic methods. Interpretation of dipmeter logs. Electrofacies and depositional environments. Preparation facies maps. Identification of depositional environments through electrofacies

Suggested Books

1. Serra, O. and Serra, L. 2003. Well logging and geology, Serralog (Pub.), Paris.
2. Bossiouni, Z. 1994. Theory, measurement and interpretation of well logs. SPE Text Book Series, Louisiana, USA.
3. Bateman, R.M. 1985. Open-hole log analysis and formation evaluation, IHRDC, Boston.
4. James Brock, 1986. Applied open-hole log analysis, Vol.2 Gulf Pub. Co., Huston, Texas.
5. Serra, O. Fundamentals of Well Log Interpretation, 1986, Vol. 2, Elsevier Pub., Amsterdam.
6. Rider, M.H. 1985. The Geological interpretation of well logs, Blakie Pub., London.
7. Vaish, J.P. 1997. Geophysical well logging principles and practices (oil and gas) Asian Books Private Ltd., New Delhi.
8. Willie, M.K.J. 1963. The fundamentals of well log interpretation, 3rd Edn., Academic Press, London.
9. Asquith, G.B. and Gibson, C.R. 1983. Basic well log analysis for geologists. AAPG methods in exploration series, Tulsa, Oklahoma.
10. Ahmed, Khalid. Quick look log interpretation, Regional Training Institute, ONGC, Bombay.
11. Dix, C.H. 1981. Seismic prospecting for oil, IHRDC, Boston.
12. Lynch, E. J. 1976. Formation evaluation, The English Book Depot, Dehradun.
13. Hand book of well log analysis for oil and gas-formation evaluation, Prentice Hall, New Jersey, 1962.
14. Bhagawan Sahy, A Wadhesh Rai and Manoj Kumar Ghosh 1983. Formation evaluation and well site geological techniques, ONGC, Bombay.
15. Gupta, P.K. and Nandi, P.K.1994. Well site geological techniques and formation evaluation – A user manual Vol. I, ONGC, Dehradun.

PES 202: SEISMIC EXPLORATION AND STRATIGRAPHY

Unit – 1: Concept of Seismic Surveys

Seismic reflection survey methods – concept of 2D, 3D and 4D field surveys – elements of signal processing – Reflection models – Multiples – Diffractions – Fresnel zones – P & S waves – Birefringes – Amplitude variation with offset (AVO) and quantitative seismology – Velocity determinations: Interval velocity – Average velocity – Apparent velocity – Wave propagation – Amplitude decay and attenuation. Lay out design considerations for AVO – Fringe zone – 3D migration. Wireline and wireless telemetry – Navigational systems for position location onland and offshore. Field processing and quality control of acquired data.

Unit – 2: Well Bore Seismics

Well bore seismics – VSP theory – Data acquisition and interpretation – Offset VSP – Walk away VSP – Synthetic seismogram – Well velocity survey – Time-depth curves.

Unit – 3: Seismic Data Analysis

Basic concepts and definitions – Seismic reflection character analysis – Wave propagation – Amplitude decay and attenuation – Forward and inverse modelling concepts – Synthetic seismogram – Direct hydrocarbon indicators – Seismic inversion – Seismic attribute analysis – Seismic Modelling – Application of seismic reflection technique for exploration and reservoir (production) monitoring – Onland, transition zone shallow and deep waters - Migration – 3D migration.

Unit – 4: Seismic Data Interpretation

Concepts of seismic interpretation – Structural mapping – correlation of seismic reflectors – Mapping of stratigraphic traps – Preparation of Isochron maps – Isochronopach maps – 4C-4D concepts – Visualisation and reservoir characterization – Bright spots – dim spots – Flat spots – Velocity pull up – Pitfalls in seismic data interpretation.

Unit – 5: Seismic Stratigraphy

Seismic sequence analysis – Sequence identification – Chronostratigraphic sequence analysis – Interpretation of depositional environments – Lithology – Eustatic sea level changes – Seismic facies analysis – Stratigraphic interpretation.

Suggested Books

1. Sengbush, R.L. 1986. Petroleum Exploration: A quantitative introduction. I.H.R.D.C., Boston.
2. Domenico, S.N. 1983. Modern seismic exploration concepts, Amoco Production Co., Tulsa, Oklahoma.
3. Macquillin, R; Bacon, M (Eds.), 1984. An introduction to seismic interpretation, reflection seismics in petroleum exploration, Grahman Trotman.
4. Hardage, B.A. 1987. Seismic stratigraphy, Geophysical Press, London.
5. Waters, K.H. 1979. Reflection seismology – A tool for emerging resource exploration. John Wiley and Sons.
6. Galperin, E.I. 1989. New potential in seismic exploration, E.B.D. Educational Pvt. Ltd., Dehradun.

7. Sherif, R.E. and Geldart, L.P. 1995. Exploration seismology. Cambridge University Press, U.K.
8. Coeffeen, J.A., 1986. Seismic exploration fundamentals, 2nd Edn., Pennwell, Tulsa, Oklahoma.
9. Emery, D; Myers, K.J. (Eds.). 1996. Sequence stratigraphy Blackwell Sci., Oxford.
10. Hailwood, E.A. and Kid, R.B (Eds.). 1993. High resolution stratigraphy, Geological society special publication No. 70, London.
11. Sheriff, R.E. (Ed.). 1982. Seismic stratigraphy, The English Book Depot, Dehradun.
12. Payton, C.E. (Ed.). 1977. Seismic stratigraphy and application to hydrocarbon exploration, Tulsa, U.K., AAPG Memoir – 26.

PES 203: RESERVOIR ENGINEERING AND MANAGEMENT

Unit 1: Principles of Reservoir Engineering

Scope and importance of reservoir engineering
Sedimentary formations suitable for hydrocarbon reservoirs
Brief description of 'origin' 'migration' and 'accumulation' processes of hydrocarbon fluids.
Physical properties of reservoir rocks like:
Porosity (total and effective), permeability (absolute, effective and relative), grain-size distribution, compressibility and wettability.
Darcy's law for fluid flow in porous media, application to linear and radial systems; fluid flow characteristics of binary-phase flow systems with respect to phase-saturations
Explanation of terms: Connate water saturation and irreducible oil saturation.
Physical and chemical properties of hydrocarbon gases and liquids, compressibility factors, broad composition of hydrocarbon gases and liquids, viscosity of hydrocarbon liquids and effect of temperature on viscosity.
Effect of temperature and pressure on the solubility of hydrocarbon gases.
Concept of capillary pressure, transition zone and tilted oil-water contact.
Pressure transient analysis, pressure built up test, reservoir limit test (RLT).

Unit 2: Gas-Liquid Equilibria

P-T phase diagrams of hydrocarbon systems
Concept of critical point, bubble-point and due-point curves
Reservoir drive mechanisms – Depletion drives, displacement drives – Combination drives – Efficiency of the individual drives.
Retrograde condensation in gas reservoirs
PVT properties of reservoir fluids:
Explanation of terms 'saturation pressure' (bubble-point-pressure) Gas-oil ratio, formation volume factors (FVF) of oil and gas, shrinkage factor of reservoir oil, differential and flash (contact) gas-liberation processes.

Unit 3: Methods of Reserve Estimation

Definition of reserves, distinction between in-place and recoverable reserves.
Estimation of reserves: Volumetric estimation, decline-curve methods, material balance method and simulation method

Definition of recovery factor and its estimation

Unit 4: Enhanced / Improved Oil Recovery Methods (EOR/IOR)

EOR concepts and criteria for application
Water-flooding as a secondary recovery method
Thermal (steam and in-situ combustion) methods
Chemical (alkaline, polymer, surfactant) flooding
Miscible gas (hydrocarbon, carbondioxide) flooding
Advantages and problems in application
Performance reviews and correction methods.

Unit 5: Reservoir Management

Concepts of reservoir management – Definitions, objectives of management, synergy and team efforts, Integration of geoscience and engineering data. Integration of exploration and development technology. Reservoir management process – Setting goals, developing plan and implementation, surveillance and monitoring, economic criteria and evaluation. Revision of plans and strategies.
Current challenges – Improved definition of reservoir characteristics. Tracking of fluids movement through the reservoir and control of their movement.

Suggested Books

1. Clark, N.J. 1969. Elements of petroleum reservoirs, 2nd Edn., SPE, Texas, USA.
2. Dake, L.P., 1998. Fundamentals of reservoir engineering. Development of petroleum science, Elsevier, Amsterdam.
3. Craft, B.C. and Hawkins, F.W. 1959. Applied petroleum reservoir engineering, Prentice Hall, New Jersey.
4. Craft, B.C., Holden, W.R. and Graves, E.D. (Jr.). 1962. Well design, drilling and production, Printice Hall, New Jersey.
5. Roebuck, I.F. (Jr.). 1983. Applied petroleum reservoir technology. Tulsa, Oklahoma.
6. Cole, F.W. 1961. Reservoir engineering manual, 2nd Edn., Gulf Engineering Co., Houston, Texas.
7. Dandekar, A.Y. 2006. Petroleum reservoir rock and fluid properties, Taylor & Francis, London.
8. Ali Danesh, 1998. PVT and phase behavior of petroleum reservoir fluids, Elsevier, Pub. Co., Amsterdam.
9. Thomas, G.W. 1982. Principles of hydrocarbon reservoir simulation. IHRDC Publishes, USA.
10. Djebbar Taib and Donalson, E.C. 2004. Petrophysics, 2nd Edn., Elsevier, Amsterdam.
11. Abdus Sattar and Ganesh Thakur, 1994. Integrated petroleum reservoir management – Team approach, PennWell Pub. Co., Tulsa, Oklahoma, USA.

PES 204 (ELECTIVE): SEDIMENTOLOGICAL AND BIO-STRATIGRAPHIC APPROACHES IN HYDROCARBON EXPLORATION

Unit 1: Sedimentological Studies

Study of outcrops, well cuttings and preparation of detailed lithologs; Core analysis and core description – Texture, grain size, porosity; heavy minerals, petrographic studies - grain size, roundness, and packing; clay mineral analysis by SEM and X ray diffraction techniques.

Unit 2: Geochemical Studies

Concepts of micro seepages – Free and adsorbed gas relationship in macro seepages.
Methods of micro seepages – Soil-gas and airborne methods – Onshore and offshore. Absorbed hydrocarbon surveys in onshore and offshore regions. Magnetic alteration of oil seepage signature and geochemical anomalies.
Preparation of geochemical anomaly maps, interpretation and integration with geological data. Application to prediction of hydrocarbons.

Unit 3: Micropalaeontological Studies

Introduction to micropalaeontology, collection and separation of microfossils from matrix. Preservation of out crop samples and well cuttings. Microscopic examination of thin sections of typical microfossils such as radiolaria, pteropods, foraminifera and diatoms. Applications of microfossils in petroleum exploration – Biostratigraphy, paleoclimate, paleobiogeography and thermal maturation of source rocks.

Unit 4: Palynological Studies

Definition of palynology, advantages and limitations of palynological studies,
Collection, separation, and preservation of palynomorphs in outcrop samples and well cuttings.
Microscopic examination of thin films of spore and pollen
Applications of palynofossils: Dating of sediments, correlation of marine and terrestrial sediments, sequence biostratigraphy, paleoenvironment, paleoclimate reconstructions and source rock evaluation studies.

Unit 5: Synthesis

Reconstruction – Tectono-stratigraphic evolution of a basin and petroleum habitat.
Correlation of bio-litho-chrono and sequence stratigraphy
Reconstruction of palaeoenvironments and depositional conditions.
Application of the above to hydrocarbon exploration.

Suggested Books

1. Zimmerle, W. 1995. Petroleum sedimentology, Kluwer Pub. Dordrecht.
2. Haq, B.U. and Boersma, A. 1998. Introduction to marine micropaleontology, Elsevier, Amsterdam.
3. Jones, R.W. 1996. Mircopalaeontology in petroleum exploration Clarendon Press, Oxford.
4. Mehrotra, N.C., Venkatachala, B.S., Swami, S.N. and Kapoor, P.N. 2002. Palynology in hydrocarbon exploration, Geol. Soc. Of India. Memoir 48, Bangalore.
5. Travers, A. 1998. Palaeopalynology, Unwin Hyman, London.
6. Emeray, D. and Myers, K.J. (Eds.). 1996. Sequence stratigraphy, Blackwell Sci., Oxford.
7. Jones, D.J. 1956. Introduction to microfossils, Harper & Brothers, New York.
8. Tedesco, S.A. 1993. Surface geochemistry in petroleum exploration, Chapman and Hall Pub. USA.
9. Hunt, J.M. 1979. Petroleum Geochemistry and Geology, Freeman, San Francisco, USA.
10. Welte, D.H., Harsfield, B. and Baker, D.R. 1979. (Eds.). Petroleum and basin evolution, Springer Verlag, Berlin.

PES 205 (ELECTIVE): SEISMIC DATA PROCESSING

UNIT-1

Introduction - 1-D, 2-D Fourier transforms, Frequency aliasing, Geometric spreading, RMS amplitude and AGC, Basic processing sequence, Basic tools of processing: Correlation, convolution, summation.

Deconvolution - Convolution model, Inverse filtering, Optimum Wiener filters, Predictive deconvolution, Problem of non stationarity.

UNIT-2

Velocity analysis and static corrections - Normal Moveout, Velocity analysis: Velocity spectrum. Measure of coherency, Interactive velocity analysis.

Static corrections: Elevation statics, Refraction statics.

Residual static corrections: Residual static estimation by Maximisation of Stack power, Residual static estimation by travel time decomposition.

UNIT-3

Migration: Migration principles. Kirchoff migration, Finite difference migration, Down ward continuation, Frequency-space Implicit and Explicit schemes, F-K migration Phase shift migration, Stolt migration.

Dip Moveout correction - Pre stack partial migration, F-K DMO correction, Log stretch DMO correction, Integral DMO correction, Turning-Wave Migration.

UNIT-4

Pre stack migration, DMO correction and common offset migration, Common reflection point versus Common Reflection Surface Stack.

Migration velocity analysis, Pre stack Stolt migration, Pre stacks Kirchoff Migration.

Signal enhancement, Noise and multiple attenuation, Coherent linear noise, Multiple attenuation in CAP domain, F-K filtering, Radon transform, Linear un- correlated noise attenuation, Spatial predictive filters.

UNIT-5

3D processing - 3D refraction statics, Azimuthal dependence of move out velocities, 3D DMO correction, 3D velocity analysis, 3D residual static correction, 3D migration.

Imaging in Depth - Lateral velocity variations, Layer replacement: Wave Equation datuming. Post stack layer replacement, Pre stack layer replacement, 2D post stack depth migration, 2D prestack depth migration, 3D post stack depth migration, 3D prestack depth migration.

Suggested Books

1. Coffeen, J.A. 1984. Interpreting seismic data, (2nd edn.). Pennwell Pub. Company, Tulsa, Oklahoma, USA.
2. Anstey, N.A (ed.). 1982. Simple seismics. IHRDC publications, Boston.
3. Hilterman, F.J. 2001. Seismic amplitude interpretation.
4. Ozyilmax, 2001. Seismic data analysis, SPG Pub., Tulsa, Oklahoma, USA.
5. Saha, J.G. Seismic data processing manual, ONGC Pub., Dehradun.
6. Sengbush, R.L. 1968. Petroleum Exploration: A quantitative introduction, IHRDC, Boston.

PES 206 (ELECTIVE): WELL COMPLETION AND INITIAL FIELD DEVELOPMENT

Unit 1: Normal Well Completion Techniques

Objectives of well completion:
Completion of a well, drilling, casing, cementation, perforation and activation
Open hole completion, perforated completion, liner completion, advantages and disadvantages of each completion
Completion in a single producing interval and multiple completions
Types of artificial lift, operating principles, merits and demerits of gas lift, ESP and SRP.
Sand control, causes and operational problems. Types of sand control methods. Gravel packing techniques. Chemical and rate control methods.
Use of packers, safety valves, side pocket mandrel etc.

Unit 2: Advanced Well Completion Techniques

Inclined wells and cluster wells
Types of horizontal wells, advantages and limitations, completion techniques. Comparison with lateral wells, ERD wells
Multilateral wells. Advantages and disadvantages

Unit 3: Oil Field Development

Discovery well, delineation and development wells, objectives of development,
well spacing – types, development of multiple pay zones.
Development of marginal fields.
Productivity improvement by stimulation methods -
Maintenance of reservoir pressure by water and / or gas injection-peripheral flooding, pattern of flooding.
Performance prediction of a pay zone

Unit 4: Well Testing

Need to test wells. Testing for generating different reservoir parameters. Corrective measures to maintain production
Productivity index test for oil wells. Interpretation of the P.I. curve. Estimation of P.I., SPI, Mobility, Permeability
Inflow performance relationship (IPR) test, and it's utility
Gas well testing – back pressure tests or modified isochronal tests.

Unit 5: Gas Reservoirs

The perfect gas law, specific gravity of gases, new ideal or real gases, gas deviation factor. Reservoir gas volume factors, densities and gradients. Calculation of gas-in-place by volumetric method. Material balance of gas reservoirs.

Suggested Books

1. Cole, F.W. 1961. Reservoir Engineering Manual, 2nd Edn., Gulf Eng. Co., Houston, Texas.
2. Craft. B.C. and Hawkins, M.F. 1959. Applied Petroleum Reservoir Engineering, Prentice Hall, New Jersey.
3. Craft, B.C. Holden, W.R. and Graves, E.D. 1962. Well design, drilling and production, Printice Hall Inc, New Jersey.
4. Mirunde, M.S. 1975. Manual on bottom hole studies for well testing and determination of reservoir parameters, ONGC, Dehradun.
5. Turaga, S.P. 2005. An introduction to oil well cement, its properties, functions and slurry design techniques. Centre for Rural Development and Environmental Studies Pub., Secunderabad.
6. Butler, R.M. Horizontal wells for the recovery of oil, gas and bitument.
7. Rev. B. 1996. Oil field familiarization – Training guide, Baker Hugs InteQ, Huston.
8. Srinivasulu, A.N., Rajvanshi, A.K. and Taneja, H.R. 1992. Well testing and stimulation: A user manual, ONGC Wire Line Research Centre, New Delhi.
9. Allen, T.O. and Roberts, A.P. Production operations, Vol. I. 2nd Edn. Oil and Gas Consultants Int. Inc., Tulsa.

PES 207 (ELECTIVE): PRODUCTION LOGGING

Unit 1:Introduction to Production Logging

Well head control. Through tubing operations. GR-CCL Tools for depth correlation. PLT Tools: Temperature – Pressure – Fluid density – Flow meters. Radio active isotope injection and tracer surveys.

Unit 2: Well Monitoring

Production – testing. Gas oil ratios and water cut. Casing / tubing / Bean sizes. Well completion details. Flow type and IPR curves.

Unit 3: Cased Hole Operations

Cement Evaluation Tools. GST/RST logs. Cement repair jobs. Perforations / reperforations. Packer – Bridge plug – casing / Tubing Punctures & cutters. Through tubing operations

Unit 4: Production Logging Analysis

Layered reservoir behaviour in producers/ injectors. Flow rate measurement by spinner, spinner flow meter calibration. Fluid identification: phase hold up by pressure gradient, radio-active fluid density and dielectric based methods. Temperature measurement: Temperature Profiles in producing and injecting wells. Anomalous temperature profiles. Pressure measurement and applications. Mono/Two phase / Three Phase flow regimes. Sick well analysis and remedial measures.

Unit 5: Recent Developments

Horizontal wells: Problems encountered with conventional logging sensors. Probe tools, hold-up imaging, phase velocity measurement. Fiber Optics. Down- hole video. Noise logging

Suggested Books

1. Soleman, J.J. 1996. Cased hole and production log evaluation, Pennwell Pub. Co., Tulsa, Oklahoma.
2. Allen, T.O. and Roberts, A.P. Production operations, Vol. 1 (1978) and Vol. 2 (1979), Oil & Gas Consultants, Inc., Tulsa.
3. Saha, G.C. and Bose, P.N.S. Production logging – Principles and Applications. Well Logging Section, ONGC, Bombay.

PES 208 (PRACTICAL): WELL LOGGING AND FORMATION EVALUATION

Drawing response curves – Caliper-SP- Gamma ray –Resistivity-Density-Sonic – Neutron against sand, shale, limestone, and coals and against water, oil and gas
Reading a log and tabulating log values
Identification of promising zones
Calculation of porosities from density and sonic values
Temperature corrections for R_{mf}
Deduction of R_w value from SP log
Calculation of S_w using various empirical relations
Identifying general lithological units from logs and calculation of shale index
Qualitative interpretation of CBL-VDL
Advanced log interpretation
Qualitative assessment of the log
Construction of porosity cross-plots and estimation of true porosity
Estimation of water saturation – Movable oil index
Resistivity porosity cross plots-Rwa overlays
Porosity cross plots-identification of lithology and minerals
Interpretation of clean sands-Identification of pay horizon
Fluid identification through logs
Interpretation of shaly sands
Dipmeter log data interpretation
Facies analysis Identification of depositional environment through electrofacies
(Calculation of dip angle and strike from circumferential image profiles
Calculation of water saturation (SW) and the quantity of oil.
Calculation of water saturation (SW) and oil saturation (SO).
Identification of oil saturation of a sand layer using log data (SP log, caliper log and resistivity log).
Calculation of porosity from density log.
Calculation of porosity from sonic log.
Calculation of SW and porosity from sonic log.
Drawing of production profile of a well using gamma ray log, casing cement bond log, fluid density log and temperature log.
Calculation of fluid velocities and flow rates.
Calculation of dip and strike of a bed from dipmeter log
Electrolog analysis, facies analysis by electrologs
Evaluation of the following information from the given data of a section of sand and shale sequences, and the perforated intervals.

a. Plotting of characteristics Natural Gamma Ray against sand, shale sequence and marking the perforated intervals.
b. Drawing the casing caller log, fluid density curve, flowing temperature curve and the production profile.

Computation of porosity and Rw from Hingle plot (Resistivity Vs Sonic travel time).
Calculation of Rw from a picket log (Resistivity Vs Porosity).
Computation of V_{clay} from a Gamma Ray log.
Computation of water saturation from (a) Indonesian, (b) Simandoux, (C) Archies equations.
Calculation of movable oil index.
Determination of effective porosity (ϕ_e) and V_{sh} from density – neutron porosity cross plots.
Construction of Tad pole plot from dip data for a geological section and interpretation of faults, current bedding, folded structures, unconformity and channel cut and fill.

PES 209 (PRACTICAL): SEISMIC EXPLORATION AND STRATIGRAPHY

Fault mapping
Fault dating
Stratigraphic interpretation
Chronostratigraphic sequence analysis
Identification of depositional environments through electrofacies.
Interpretation of seismic section – Identification of deltaic environment, facies, faults

PES 210 (PRACTICAL): SEDIMENTOLOGICAL AND BIOSTRATIGRAPHY APPROACHES IN HYDROCARBON EXPLORATION (ELECTIVE)

Calculation of grain size parameters (mean, standard deviation, skewness and kurtosis) and graphic representation of mean size (ϕ) against cumulative percentage
Identification and characterization of heavy minerals (Amphibole, pyroxene, tourmaline, ilmanite, silimanite, monazite, zircon, garnet and rutile)
Plotting of pie diagram and histogram based on the percentage of heavy minerals against their mesh size.
Identification of sedimentary structures (Herring bone cross bedding, flaser bedding, wavy bedding and lenticular bedding) from the geological sections.
Identification and analysis of microfossils (foraminifera, ostracods, diatoms etc.).
Identification and analysis of polynomorphs (pollen and spores)
Identification of the order of the geological events given in the cross section.
Identification of different types of faults and indication of tectonic regimes.
Preparation of contour maps and their interpretation.

PES 211 (PRACTICAL): SEISMIC DATA PROCESSING (ELECTIVE)

Study and extraction of parameters required for processing from observed reports
Stacking charts-CDP bins-Displays
Picking velocity function and identification of multiples
Computation of static corrections
Convolution and deconvolution of a time series with an operator
Calculation of reflection coefficients from a given subsurface model
Migration using diffraction overlay
Convolution of two wavelets
Preparation of seismic trace by convoluting reflection coefficients with a propagating wavelet
Preparation of composite trace from given component traces

PES 212 (PRACTICAL): WELL COMPLETION AND INITIAL FIELD DEVELOPMENT (ELECTIVE)

Calculation of initial oil in place by volumetric method.
Calculation of flow rate of oil and gas well, with the given data
Calculation of K_{avg} of a layered reservoir

Calculation of K_{avg} of a damaged well
Calculation of productivity index of an oil well and determining the parameters P.I., S.P.I, Hydroconductivity, Mobility, Permeability
Calculation of open flow potential of a gas well by back pressure test.
Pressure buildup test of an oil well and calculation of kr, k, skin factor, flow efficiency, p*, p etc.
Calculation of initial gas-in-place of a gas reservoir from volumetric method.
Estimation of average permeability of a damaged zone stimulated by acidisation
Productivity index test of an oil well
Correlation of reservoir parameters (viscosity, permeability and residual oil saturation) and calculation of the pore space and residual saturation from the given data.
Calculation of fluid viscosity of a well
Calculation of recovery factor
Calculation of theoretical rate from bottom hole pressure.

PES 213 (PRACTICAL): PRODUCTION LOGGING (ELECTIVE)

Production and injection profiles from flow meters
Fluid velocity from isotope surveys
Sick well analysis
Channel identification from CBL – VDL and Temperature logs.
Water hold up determination from fluid density tools/ capacitance tools.
Fluid level identification from pressure gradient.

III SEMESTER

PES 301: GENETIC BASIN MODELING

Unit 1:

Basin location and crustal evolution – Cratons- Craton interior basins, Intercontinental basins, Island Arc Systems.

Unit 2:

Basin types- Interior sag basins, intercontinental orogenic basins, Rifts, grabens, half grabens, geosynclinal basins, divergent margin basins- superimposed basins.

Unit 3:

Identification of major tectonic cycles, succession of geological events, Tectonic cycles- Basin initiation, filling mechanism, Basin Reversals- Erosion- Non deposition unconformities.

Unit 4:

Integrated Basin Analysis- Development of basin history through quantitative basin analysis of rates of subsidence, uplift and deformation of basin fill; Paleogeography, paleo- bathymetry and paleoclimate; Depositional conditions and products; fluid properties, hydrodynamics and transport (migration) of fluids; rock properties, heat

transfer and thermal history; Organic matter transformation and kinetic Processes; trap formation and competence; Accumulation, alteration and loss of petroleum in the reservoir.

Unit 5:

Development of conceptual basin model based on (i) geological evolution and tectonics of the basin in time sequence in terms of deposition of sediments, non- deposition, uplift and erosion , (ii) thermal history of the basin based on heat flow (transfer) and storage, (iii) stratigraphic history in terms of seismic, sequences and chrono stratigraphy, (iv) maturation of organic matter in source rocks, petroleum generation and migration mechanisms and path ways, and (v) accumulation and cracking of petroleum in the reservoirs.

Suggested Books

1. Dore, A.G (Ed.), 1993. Basin modeling: Advances and applications. NFE Spec. Pub. 3, Elsevier, Amsterdam.
2. Welte, D.H., Horsefield, B. and Baker, D.R. (Eds.). 1997. Petroleum and basin evolution, Springer- Verlag, Berlin.
3. Allen, P.A. and Allen (Jr). 1990. Basin analysis: Principles and applications, Black Well, Oxford.
4. Einsele, G. 1992. Sedimentary basins- evolution, facies and sediment budget, Springer, Berlin.
5. Kumar, S.P., Dwivedi, P., Benerjie, V. and Gupta, V. (Eds.). 2000. Petroleum geochemistry and exploration in the Afro- Asian region, Balkema, Rotterdam.
6. Cross, T.A. (Ed.). 1990. Quantitative dynamic stratigraphy, Prentice Hall, U.K.
7. Payton, C.E. (Ed.). 1977. Seismic stratigraphy – Applications to hydrocarbon exploration.
8. Visher, G.S. 1984. Exploration stratigraphy. Penn Well Pub., Tulsa.
9. Somerton, W.H. 1992. Thermal properties and temperature related behavior of rock / fluid systems. Developments in petroleum science 37, Elsevier, Amsterdam.
10. Mattvelli, L. and Novelli, (Eds.) Advances in organic geochemistry – 13, Pergamon Press, Oxford.
11. Schenck, P.A. and Havennar, I. (Ed.) 1969. Advances in organic geochemistry, Pergaman Press, Oxford.
12. Magra, K. 1986. Geological models of petroleum entrapment, Elsevier, Amsterdam.

PES 302: PROGNOSTICATION AND PROSPECT EVALUATION

Unit 1: Prognostication of Resources

Definition of prognostication. Methods of prognostication – Qualitative and quantitative. Division of a basin into zones based on qualitative prognostication.
Basin wise and country wise prognostication of reserves

Unit 2: Prospect Identification and Evaluation

Prospect identification and analysis, play types and related petroleum systems. Estimation of oil & gas reserves for identified prospects.
Different methods of estimation of in place reserves. Validation / modification of inplace reserves,
Prospect Prioritization

Unit 3: Reservoir Parameter Maps

Preparation of isoporosity, isopermeability, isopay and isosaturation maps.
Preparation of structure maps at different stratigraphic and pay levels – Preparation of isochronopach maps – Identification of prospective leads, suitable exploratory locales and hydrocarbon bearing levels.
Periodic review of the maps based on the new development well data.

Unit 4: Techno-Economic Analysis of Oil and Gas Fields

Economic balance and cost-benefit analysis in drilling and production operations. Economic evaluation of the prospect and the oil property. Present day value of the oil, property-discount rate, average annual rate of return, amortization, profit to investment (PI) ratio, and payout time, forecasting economic scenario

Unit 5: Environmental Impacts of Drilling and Production Operations

Environmentally safe drilling practices
Environmental impact Assessment of onshore and offshore oil fields.
Contingency and emergency responses.
Safety and health aspects.

Suggested Books

1. Clearbout, J. F. (1976). Fundamentals of geophysical prospecting data processing with application to petroleum prospecting McGraw Hill Pub., U.K.
2. Campbell, J. M. (1959). Oil property evaluation, Printice Hall, N.J
3. Van Mours, A.P.H. (1971). Petroleum economics and offshore mining legislation, Elsevier Pub. Co., Amsterdam.
4. Abdel-Aal, H.K. Barker, B.A. and Al-Sahlawi, M.A. (Eds.). 1992. Petroleum Economics and Engineering, 2nd Edn., Marcel Dekker, Inc.
5. Sahay, B., Roy, A. and Ghosh, M.K. 1991. Well site geological techniques for petroleum exploration, Oxford – IBH.
6. Freize, P.A, McGreger (ed.). (1984). Marine offshore safety, Elsevier
7. Navarro, A. 1994. Environmentally safe drilling practices. Pennwell Books, Tulsa, Oklahoma.
8. Freize, P.A., Mc Griger (Eds.) 1984. Marine and offshore safety, Elsevier Pub., Amsterdam.

PES 303: OIL & GAS FIELD DEVELOPMENT

Unit 1: Classification of Reserves

Definition of terms – Reserves and recoverable reserves

Types of reserves – Proved, proved subeconomic and inferred reserves.
Classification of reserves – Proved: Categories A, B, C_1; Proved subeconomic – Category Z; and inferred: Category C_2.
SPE/WPC definitions and classification of reserves – Proved, unproved, probable and possible reserves.

Unit 2: Reservoir Simulation

Criteria for reservoir simulation process – input data gathering, history matching and performance prediction.
Classification of simulations based on type of reservoir –gas reservoir simulations, black-oil reservoir simulators and compositional reservoir simulations.
Input data for black oil simulation – General data of the reservoir, rock and fluid data, grid data, production / injection and well data.
History matching – Verification of input initial data, pressure matching and saturation matching.
Performance prediction – Future performance prediction based on existing operating conditions or alternative development plan inorder to maximize economic recovery of hydrocarbons from the reservoir.

Unit 3: Field Development

Criteria for field development – Basic geological data for development planning. Data collection from initial wells.
Discovery well – Delineation of the field limits – Volumetric estimation of in place reserves – Planning development wells based on the reservoir parameters and economic criteria – Well spacing - Final development plan – Rate of production – Oil recovery factor – Water injection – Pressure maintenance – Abandoning the field – Abandonment pressure.

Unit 4: Bottom Hole Studies

Collection of reservoir samples, performance of routine reservoir tests like productivity index , build-up test, draw down test, interference test, back pressure test, and isochronal test. Calculation of reservoir parameters like, K, Kh, Skin, flow efficiency, P.I., P*, P etc. and other PVT parameters. Significance of pressure and temperature data in hydrocarbon exploration and exploitation.

Unit 5: Identification and Treatment of Sick Wells

Definition of a sick well, criteria for identification of sick well – Channeling, Channel detection – Cement bond log (CBL) - Variable density log (VDL) - Cement evaluation tool (CET) - Remedial measures – Cement squeeze.
Sickness due to leakage – Detection of leakage, temperature survey, temperature anomaly, Radioactive isotope (tracer) survey, Activated oxygen log, isolation by packers. Reperforation and activation.

Suggested Books

1. Cole, F.W. 1961, Reservoir Engineering Manual, 2nd Edn.Gulf Eng Co, Huston, Texas
2. Craft, B.C. and Hawkins, F.W. 1959. Petroleum Applied Reservoir Engineering practice Hall, New Jersey
3. Craft B.C., Holden W.R. and Graves, E.D. (Jr). 1962, Well design, drilling and production practice Hall mc, New Jersey.
4. Mirgunate, M.S. 1975. Manual on bottom hole studies for well testing and determination of reservoir parameter, ONGC, Dehradun.
5. Allen, O.T. and Roberts, A.P. Production operations, Vol.2, 1978, Oil and Gas Consultants International Inc., Tulsa.
6. Rev, B. 1996. Oil field femilierisation- Training Guide, Baker Hugs InteQ, Huston.
7. Peaceman, D.W. 1977. Fundamentals of Numerical Reservoir Simulation.
8. Thomas, G.W. 1982. Principles of hydrocarbon reservoir simulation.
9. Mattax, C.C. and Dalton, R.L 1990. Reservoir Simulations, S.P.E. Pub. USA
10. Fanchi, J.R. 2001. Principles of applied reservoir simulation, 2nd eds, Elsevier, Amsterdam.
11. Abdus Satter and Ganesh Thakur. 1994. Integrated petroleum reservoir management – Team Approach, Pennwell Books, Tulsa, Oklahoma.

PES 304: HYDROCARBON PRODUCTION

Unit 1: Onland and Offshore Production Facilities

Flow-lines from wells - Group Gathering Stations – Oil, water, and gas separators – Storage tanks – Gas flaring - Pumps
Central Tank Farm – De-emulsification and desalination units – Stabilization of crude oils
Auxiliary equipment: Heater Treaters – Effluent water disposal units – Gas flaring units
Pumps – Output meters- Pipelines
Offshore Facilities: Production platforms (GGS) – Processing Platform (CTF) –Gas flaring units - Sub sea pipelines – Landfall points
Mooring systems for loading and unloading oil from production platforms to tankers and from tankers to landfall points

Unit 2: Production Logging

Well head control for carrying out logging in flowing wells –
Through tubing combination tools and principles of measurements –
Casing /tubing collar locator –
Gamma ray tool for correlation –
Temperature – Pressure- Fluid density – Flow meters.

Unit 3: Production Monitoring and Flow Assurance

Production well Monitoring– Productivity index test (PI) and inflow performance relation measures for test (IPR).
Continuous production monitoring of offshore wells (sub-sea completion) – Measures for uninterrupted oil flow from well to platform. Measures to inhibit paraffin deposition-

hydrate formation, and liquid slugging within tubings, and flow lines. Chemical injection and thermal insulation techniques – Sweep efficiency – Linear flow.

Unit 4: Production Potential

Estimation of production potential of an oil well based on reservoir parameters – pay thickness-porosity-permeability and saturation.
Estimation of peak production potential of the wells.
Estimation of the production potential of the field based on the number of producing wells and well spacing.
Preparation of annual production plans and their review.

Unit 5: Model Pipeline Studies

Demulsification of emulsion crudes
Desalination of high saline crudes
Transport of crude through pipelines
Stimulators / pour point depressants
Corrosion of sub sea pipelines, and prevention methods

Suggested Books

1. De Bouw, R. Millich, E.M. (eds.) (1985). New technologies for exploration and exploitation of oil and gas resources. Vol. I&II, Grahmam Trotman Pub.
2. Hobson, G.D. (ed.) (1973). Modern Petroleum Technology 4th Edn., Applied. Sci. Pub. London.
3. Craft B.C and Hawkins,F.W.1959.applied Petroleum Reservoir Engineering, Practice Hall, New Jersey.
4. Cole, F.W. 1961. Reservoir engineering manual, 2nd Edn., Gulf Eng. Company, Huston, Texas.
5. Bhagwan Sahay. 2001. Petroleum exploration and exploitation, 3rd Edn., Allied Pub., New Delhi.
6. Jain, K.C. and de Figueiredo, J.P. 1982. concepts and techniques in oil and gas exploration. SEE Pub., Tulsa, Oklahoma.
7. Allen, T.O. and Roberts, A.P. 1978. Production operations, Vol. 2, 1978. Oil and gas consultants international, Inc., Tulsa.
8. Nind, T.E.W. 1964. Principles of oil well production. Mc. Graw – Hill Co., New York.
9. Craft, B.C. Holden, W.R. and Graves, E.D. (Jr.). 1962. Well design, drilling and petroleum, Printice Hall, Inc., New Jersey.

PES 305: MANAGEMENT ASPECTS IN HYDROCARBON EXPLORATION

Unit 1:

Definition of management, its nature and purpose
Functions of managers – Planning, organizing, staffing, leadering, controlling and coordinating. Negotiating skills

Quantitative methods of management - project management by network techniques, data base, material management.

Unit 2:

Petroleum economics –
Time value in capital expenditure
Depreciation and depletion of reserves
Financial measures and profitability analysis,
Risk, uncertainty and decision analysis
Breakeven and sensitivity analysis.

Unit 3:

Oil and gas accounting –
Basic types of costs – Acquisition costs, exploration costs, development costs and production costs.
Cost methods – Successful efforts (SE) and full costs (FC)
Financial statements

Unit 4:

Petroleum Laws and policies
Liberalization of petroleum industry in India - NELP and its impact
Preparation of bid documents for bidding blocks of exploration

Unit 5:

International business management, Joint Ventures in petroleum exploration & exploitation.
Production sharing contracts

Suggested Books

1. Wall, J.D. 1980. Environmental management hand book hydrocarbon prospect industries, Gulf Publications.
2. Abdel-Aal, Bakr, B.A. and Al-Sahlawi (Eds.). 1992. Petroleum economics and engineering, 2nd Edn., Marcel Dekker Inc., New York.
3. Varshney, R.L. and Maheswari, K.L. 2006. Managerial Economics, 19th Edn., Sultan Chand & Sons., New Delhi.
4. Koontz, H. and Weihrich, H. 2007. Essentials of management, 7th Edn., Tata McGraw Hill, New Delhi.
5. Prasad, L.M. 2006. Organisational behavior, 4th Edn., Sultan Chand & Sons, New Delhi.
6. Luthans, F. 2005. Organisational behavior, 10th Edn., Mc-Graw Hill International Edn., Singapore.
7. Keat, P.G. and Young, P.K.Y. 2004. Managerial Economic, pears education Inc., Indian reprint.

8. The mines act. 1952 along with mines rules, 2004. Universal Law Publishing co. Pvt. Ltd., Hyderabad.
9. Gallun, B.A. and Stevenson, J.W. 1988. Fundamentals of oil and gas accounting. Pennwell Books, Tulsa, Oklahoma.
10. Abus Satter and Ganesh, C.G. 1994. Integrated petroleum reservoir management, Pennwell Books, Tulsa, U.K.
11. Van Mours, A.P.H. 1977. Petroleum economics and offshore mining legislation, Elsevier, Pub., Amsterdam.

IV SEMESTER

PES 401: MAJOR PROJECT AND DISSERTATION (WITH INDUSTRY)

PES 402: PROJECT SEMINAR

PES 403: COMPREHENSIVE VIVA-VOCE