M. Tech. Petroleum Exploration
Credit Structure

	Semester I	Semester II	Semester III	Semester IV	Total Credits
Core Courses	6	6	---	---	12
Dept. Electives	24	12	---	---	36
Institute Electives	---	6	---	---	6
Courses from outside the Department	---	6	---	---	6
Lab Course	5	---	---	---	5
Seminar	4	---	---	---	4
R&D Project	---	9	---	---	9
Communication Skill	+4	---	---	---	+4
Training (P/NP)	---	---	---	---	---
Course Credits	39+4	39	---	---	78+4
Project Credits	---	12	30	42	84
Total Credits	**39+4**	**51**	**30**	**42**	**162+4**

Course Outline
First semester: (Total credits 39+4)

Second Semester: (Course credits= 30, R&D Project credits=9, Project credits 12; Total course credits= 51)

Third Semester- Project Credits 30

Fourth Semester- Project Credits 42

Total credits: 162 +4

M. Tech. Petroleum Exploration
Course outline

First semester: (Total credits 39+4)
Core courses (one course compulsory)
Petroleum Geology and Exploration Methods

Elective courses (any four)
Exploration Geophysics
Basin Analysis and Applied Micropaleontology
Remote Sensing, GIS and GPS
Structural Geology and Subsurface Geological Mapping
Well-site Geology and Formation Evaluation
Seismic Data Processing & Seismic Stratigraphy
Oilwell Drilling Technology

Lab Course: Methods in Structural Geology 5
Seminar: 4
Communication skills: +4

Second Semester: (Total course credits 39 + project credits 12)
Core course: (One compulsory course)
Well logging

Department Electives: (Any two)
Any two from below
Reservoir Sedimentology
Petroliferous Basins of India
Sequence Stratigraphy in Petroleum Exploration
Petrophysics

R&D Project
Six weeks program either in ONGC or BG Lab.

Courses Outside Department (may be dropped and in place one more department elective can be given)
Energy resources Economics and Environment

Institute Elective (one)
Cost Benefit Analysis
Environmental Planning and Development
Project Management
Human Resource Development
Environmental Change and Sustainable Development
Remote Sensing for Sub-Surface Water Resources
Natural Disaster Assessment and Management

M. Tech. Petroleum Exploration
Course details

Petroleum Geology and Exploration Methods (3 0 0 6) (hours per week, Lecture=3, Tutorial=0, Practical=0; Credit=6)

Origin and composition of petroleum and natural gas, source rocks, reservoir rocks and traps. Migration and accumulation of oil and gas. Types of petroliferous basins and their relation to hydrocarbon potential. Geographic and stratigraphic distributions of oil and gas. Methods and techniques for petroleum exploration, Surface indications and direct detection of hydrocarbons. Sub-surface geological methods and brief idea about geologic interpretations of seismic data. Drilling methods, drilling equipments, drilling fluids, well-logs. Estimation of reserves and resources. Petroleum economics, production and development geology.

Texts/References

Tissot, B.P. and Welte, D.H. Petroleum Formation and Occurrence, 2nd Edition, Springer-Verlag, Berlin, 1984.
North, F.K. Petroleum Geology, Allen & Unwin, London, 1985.
Hunt, J.M. Petroleum Geochemistry and Geology, 2nd Edition, W.H. Freeman, San Fransisco, 1996.
Sahay, B., Rai, A. and Ghosh, M. Wellsite Geological Techniques for Petroleum Exploration, Oxford & IBH, New Delhi, 1984.
Selley, R.C. Elements of Petroleum Geology, 2nd Edition, Academic Press, London, 1997.

Exploration Geophysics (3 0 0 6)

Seismic Exploration Theory and geometry of seismic waves, seismic velocity, characteristics of seismic events, seismic sources and equipment. Reflection and refraction field method. Data processing-fourier analysis, convolution, correlation, filtering, velocity analysis, stacking and migration, seismic stratigraphy seismic sequences, facies and reflection character analysis, hydrocarbon indicators, seismic interpretation. Gravity and Magnetic methods Principles and methods of gravity and magnetic prospecting, instrumentation, data processing, interpretation with case studies.

Texts/References

Sheriff, R.E. and Geldart, L.P. Exploration Seismology, Cambridge University Press, Cambridge, 1995.
Telford, W.M., Geldart L.P., and Sheriff, R.E. Applied Geophysics, Cambridge University Press, Cambridge, 1990.
Dobrin, M.B. and Savit, C.H. Introduction to Geophysical Prospecting, McGraw Hill, New York, 1988.

Robinson, E.S. and Coruh, C. Basic Exploration Geophysics, John Wiley & Sons, New York, 1988.

GS 679 Basin Analysis and Applied Micropalaeontology (3 0 0 6)

Basin classification and their characteristics; tectonic framework of basins and their architecture; economic significance of basin analysis; facies concept, process-response models and interpretation of sedimentary environments; carbonate and clastic facies models; seismic facies and stratigraphy; well-log facies application in sequence stratigraphy; sequence stratigraphy; stratigraphic correlation; basin mapping structure and isopach contouring, lithofacies and biofacies maps, preparation of stratigraphic cross-sections and palaeogeographic synthesis; regional and global stratigraphic cycles. Surface and subsurface sampling methods for micropalaeontological studies; brief description of major microfossil groups used in hydrocarbon exploration; palaeoenvironmental interpretation using microfossils; biostratigraphic classification, dating and correlation of stratigraphic sequences, standard planktonic foraminiferal zones; application of micropalaeontology in sequence stratigraphy; case studies of Indian sedimentary basins.

Texts/References

Miall, A.D. Principles of Sedimentary Basin Analysis, 3rd Edition, Springer-Verlag, Berlin, 2000.
Busby, C.J. and Ingersoll, R.V. Tectonics of Sedimentary Basins, Blackwell Science, Oxford, 1995.Reading, H. Sedimentary Environments: Processes, Facies and Stratigraphy, Blackwell Science, Oxford, 1996.
Haq, B.U. and Boersma, A. Introduction to Marine Micropaleontology, Elsevier, Amsterdam, 1998.

Remote Sensing, GIS and GPS (3 0 0 6)

Fundamentals of remote sensing, digital image data formats, image rectification and restoration techniques - geometric correction, radiometric correction and noise suppression, image histograms, density slicing, image enhancement techniques contrast manipulation, spatial filtering and edge enhancement, multi-image manipulations spectral ratioing, vegetation indices, principal components analysis, multi-spectral image classification involving supervised and unsupervised algorithms, Recent developments and applications.
Fundamentals of GIS, vector, raster and attribute data models, vector and raster data structure, spatial data input and editing, visualization and query of spatial data, spatial data transformations, spatial analysis, case studies of geological applications, current issues and trends in GIS. Principles of global positioning systems (GPS) and its applications.

Texts/References

Jensen, J.R. Introductory Digital Image Processing: a Remote Sensing Perspective, Prentice Hall, New Jersey, 1996.
Gupta, R.P. Remote Sensing Geology, 2nd edition, Springer-Verlag, Heidelberg, 2002.
Lillesand, T.M. and Kiefer, R.W. Remote Sensing and Image Interpretation, John Wiley & Sons, New York, 2000.
Benhardsen, T. Geographic Information Systems: an Introduction, John Wiley & Sons, New York, 2002.
Bonham-Carter, G.F. Geographic Information System for Geoscientists Modelling with GIS, Pergamon Press, Oxford, 1994.

Structural Geology and Subsurface Mapping (3 0 0 6)

Brittle and ductile deformation of rocks. Mechanisms of deformation. Folds, faults and fault-fold association. Balanced cross section. Fractured reservoirs. Effects of faulting on reservoirs. Mapping faults and faulted surfaces, Structural style in different tectonic settings. Structures in compressional, extensional and strike-slip terranes, Gravity induced structures. Diapirism. Stratum contour and isopach maps for structural and stratigraphic interpretation of reservoir units.

Texts/references

Groshong, R.H. 3-D Structural Geology: A Practical Guide to Surface and Subsurface Map Interpretation, Springer-Verlag, Berlin, 2000.
Tearpock, D.J. and Bischke, R.E. Applied Subsurface Geological Mapping with Structural Methods, Prentice Hall, New Jersey, 2002.
Coward, M.P., Daltaban, S. and Johnson, H. Structural Geology and Reservoir Characterization, Geological Society of America Publishing House, 1998.

Well-site Geology and Formation Evaluation (3006)

Duties of a well-site geologist. Geotechnical order. Introduction to well construction principles. Lithologic well logging. Coring and core analysis. Examination of well cuttings. Preparation of lithologs. Drill time logging, mud logging. Detection of oil and well logging. Preparation of composite logs. Principles of formation testing. Well completion, well acidisation, velocity shooting and fracturing.
Concept of formation evaluation and log interpretation. Response of logging tools and borehole effect on log measurements. Logging practices, log quality control and environmental correction on well log measurements. Lithology plots. Saturation, irreducible saturation and permeability studies from well logs. Shaly sand analysis. Cementing quality monitoring. Theory of transient well testing, use of pseudopressure in gas well testing. Constant bottomhole pressure tests. Practical aspects of design and performance of field tests. Analysis of transient pressure data, effects of boundaries,

reservoir heterogeneity, multiphase flow. Study of production, DST and formation interval tests. Pulse testing and multiwell tests.

Texts/References

Sahay, B., Rai, A. and Ghosh, M. Wellsite Geological Techniques for Petroleum Exploration, Oxford & IBH, New Delhi, 1984.
Gupta, P.K., Nandi, P.K. Wellsite Geological Techniques and Formation Evaluation: A User's Manual, Vol. I, Dehra Dun, Oil and Natural Gas Corporation, 1995.
Whittaker, A. Mud Logging Handbook, Prentice-Hall, Englewood Cliffs, 1991.
Darling, T. Well logging and Formation Evaluation, Elsevier Science, Amsterdam, 2005.
Ransom, R.C., Practical Formation Evaluation, John Wiley & Sons, 1995.

Seismic Data Processing and Seismic Stratigraphy (3006)

Review of techniques of seismic data acquisition for land and offshore areas using impulsive and vibratory energy sources. Nature of seismic records and recording parameters. Fundamentals of time series analysis, sampled time series, sampling theorem and aliasing, synthesis and analysis of waves and Fourier transform, spectral analysis and filtering. Basic data processing sequence, first-order data processing steps from treatment of field data to intermediate stacks, marine and land seismic data. Processing refinements, essential refinements to improve the seismic image including relative amplitude recovery, deconvolution, velocity analysis and residual statistics. Advanced processing, wavelet processing, filter design, velocity filtering and other sophisticated techniques for data enhancement. Migration techniques, generalized inversion, refraction statistics, and seismic tomography. Seismic modeling, forward modeling, interpretive processing. Basic concepts, definitions and objectives of seismic stratigraphy, Brief review of seismic data processing for stratigraphic needs, wavelet processing. Stratigraphic patterns in seismic data, seismic reflection character analysis, amplitude and continuity, seismic interpretations, interpretation procedures for stratigraphic traps. Seismic sequence analysis - the geologic models, picking of unconformities and mapping of seismic sequence. Seismic Facies analysis- seismic reflection characteristics, simple and complex reflection configuration, interpretation of depositional environment and lithology, eustatic sea level changes, seismic modeling - introduction, forward and inverse modeling concepts. Seismic data interpretation.

Texts/References

Sheriff, R.E. and Geldart, L.P. Exploration Seismology, (2nd edition), Cambridge University Press, 1980
Yilmaz, O. Seismic Data Processing, Society of Exploration Geophysicists, Tulsa, Oklahoma, 1987.
Yilmaz, O. Seismic Data Analysis: Processing inversion and interpretation of seismic data (Vols. 1&2), Society of Exploration Geophysicists, Tulsa, Oklahoma, 2001.
Payton, C.E. Seismic Stratigraphy- applications to hydrocarbon exploration. Memoir of the American Association of Petroleum Geologists 26, 1977.

Hardage, B.A. Seismic Stratigraphy, Pergamon Press, 1985.

Oilwell Drilling Technology (3 0 0 6)

Introduction to drilling methods, types of drilling operations, Designing an oil well, Downhole equipment, The drilling rig - its components and functions, rig sizing and selection, Drilling fluids, Wellheads, Casing and cementing operations, Principles of kick control, fishing jobs, The drill stem test (DST). Drilling a well- from top to bottom, Drilling methods and equipment for directional, horizontal and multilateral wells. Prediction of formation pore pressure and stress gradients. Determination of safety mud weight bounds for different in-situ conditions. Types of offshore drilling rigs- bottom founded vs. floating, Special issues for offshore drilling operations- motion compensation, station keeping. Stresses around a borehole, hole stability. Drilling in overpressured regimes, Drilling in depleted zones, underbalanced drilling. Shale drilling, mud programs for shale drilling. Waste disposal and environmental factors in drilling.

Texts/References

Chilinger, G.V. and Vorabutr, P. Drilling and drilling fluids. Elsevier Science, Amsterdam, 1981.
Hyne, N.J. Nontechnical guide to petroleum geology, exploration, drilling and production, 2nd edition, Pennwell Corporation, Tulsa, Oklahoma, 2001
Baker, R., A primer of oilwell drilling: a basic text of oil and gas drilling, Petroleum Extension Service, University of Texas at Austin, 2001.
Committee on Advanced Drilling Technologies, Drilling and excavation Technologies for the Future, National Academic Press, 1994.
Nguyen, J.P., Drilling, Editions Technip, Paris, 1996.

Methods in Structural Geology (0 1 3 5)

Practical strain analysis: Displacement, strain ellipse, heterogeneous strain, displacement vector, Strain measurement with respect to a line and angle, stereographic analysis, strain in three dimension, planar and linear, strain rate, palaeostress measurement, pressure gauge, rheology gauge, 3-D Structural Geology: surface and subsurface map interpretation, balanced cross section, U- stage, Special techniques in structural analysis.

Texts/References

Ramsay, J. G. and Huber, M. I. The Techniques of Modern Structural Geology, Volume 1. Strain Analysis, Academic Press, London, 1983.
Groshong, R.H. 3-D Structural Geology: A Practical Guide to Surface and Subsurface Map Interpretation, Springer-Verlag, Berlin, 2000.
Passchier, C.W. and Trouw, R.A.J. Microtectonics, Springer-Verlag, Berlin, 1996.

Tearpock, D.J. and Bischke, R.E. Applied Subsurface Geological Mapping with Structural Methods, Prentice Hall, New Jersey, 2002.
Coward, M.P., Daltaban, S. and Johnson, H. Structural Geology and Reservoir Characterization, Geological Society of America Publishing House, 1998.

Well logging (3 0 0 6)

Well logging and geology, Formation evaluation, Archie s formulae, Well drilling technology, Drilling fluids, Borehole environment, Invasion profiles, Principles, methods and application of logging tools including Spontaneous polarization, Resistivity, Microresistivity, Induction, Sonic, Density, Litho-density, Neutron, Pulsed neutron, Natural Gamma ray, Gamma ray spectrometry, Cement bond, Variable density, Caliper, Dipmeter, Formation microscanner and imager. Well log interpretation - quick look techniques, Hingle, Pickett, MID, M-N cross plots, saturation estimation, lithology, porosity and permeability determination, Log interpretation case studies.

Texts/References

Serra, O. Well Logging and Geology, Editions Technip, Paris, 2003. Schlumberger Manual Log Interpretation Principles/Applications, Vol. 1 & 2, Schlumberger Education Services, New York, 1989.
Serra, O. Fundamentals of Well Log Interpretation, Vol.1 and 2. Elsevier, Amsterdam, 1984.
Asquith, G. and Gibson, C. Basic Well Log Analysis for Geologists, Academic Press, London, 1982.
Bateman, R.M., Open Hole Log Analysis and Formation Evaluation, Reidel, Dordrecht, 1985.
Rider, M.H. The Geological Interpretation of Well Logs, Blackie, London, 1985.

Reservoir Sedimentology (3 0 0 6)

Facies diagnosis and facies models of carbonates, classification of carbonate rocks; standard microfacies types; carbonate diagenesis; porosity evolution and diagenesis in sequence stratigraphic framework; pore geometry and performance of reservoir rocks; relationship of depositional environments with the development of reservoirs.
Properties of sandstone, environment of deposition of sandstone; sandstone classification, porosity evolution in course of sandstone diagenesis; characteristic reservoir morphology and criteria for recognition of eolian, fluvial, coastal, deltaic, shelf and basin sandstone bodies; reservoir heterogeneity; petrophysical analysis using logs; reservoir sedimentology of Indian petroliferous basins.

Texts/References

Berg, R.R. Reservoir Sandstones, Prentice Hall, New Jersey, 1986.
Moore, C. H. Carbonate Reservoirs, Elsevier, Amsterdam, 2001.

Barwis, J.H. Sandstone Petroleum Reservoir, Springer-Verlag, Berlin, 1990.
Zimmerle, W. Petroleum Sedimentology, Kluwer Academic Publishers, Dordrecht, 1995.

Petroliferous Basins of India 3 0 0 6

Types of petroliferous basins, relations between basin type and hydrocarbon richness; classification of petroliferous basins of India; Detailed study of stratigraphy, structure and petroleum geology of Assam shelf, Cambay and Bombay offshore basins; Potential source rocks, reservoir rocks and exploration targets of Krishna-Godavari, Mahanadi, Cauvery, Bengal, Kutch, Saurashtra and Rajasthan Basins; Curent status of exploration and prospects in Indo-Gangetic plains, Kashmir valley and Vindhyan Basins.

Texts/References

Biswas, S.K., Dave, A., Garg, P., Pandey, J., Maithani, A. and Thomas, N.J. (Eds.). Proceedings of 2nd Seminar on Petroliferous Basins of India, Dehra Dun, Dec.18-20, 1991, Vol. 1 & 2, Indian Petroleum Publishers, Dehra Dun, 1993.
Biswas, S.K., Dave, A., Garg, P., Pandey, J., Maithani, A. and Thomas, N.J. (Eds.). Proceedings of 2nd Seminar on Petroleum basins of India, Dehra Dun, Dec. 18-20, 1991, Vol.3, Indian Petroleum Publishers, Dehra Dun, 1994.
Singh, L. Oil and Gas Field of India, Indian Petroleum Publishers, Dehra Dun, 2000.
Bhandari, L.L., Venkatachala, B.S., Kumar, R., Swamy, S.N., Garga, P. and Srivastava, D.C. (Eds.). Petroliferous Basins of India, Petroleum Asia Journal, Himachal Times Group, 1983.

Sequence Stratigraphy in Petroleum Exploration

Historical developments of sequence stratigraphy, key concepts, transgressions and regressions. Sequence stratigraphic surfaces, types of stratal terminations, Systems tract: Lowstand systems tract, Highstand systems tract, Falling stage systems tract, Regressive systems tract. Hierarchy of sequences and sequence boundaries; Sequence stratigraphy of hydrocarbon reservoirs; Applications to source rocks exploration. Application of sequence stratigraphy in Clastic and carbonate depositional systems. Case studies showing applicability of sequence stratigraphic concepts for understanding petroleum plays.

Texts/References

Emery, D. and Myers, K.J. Sequence Stratigraphy. Oxford, U.K., Blackwell, 1996.
Catenuanu, O. Principles of Sequence Stratigraphy. Elsevier, Amsterdam, 2006.
Miall, A.D. The geology of Stratigraphic Sequences. Springer-Verlag, Berlin, 1997.
Miall, A.D. Principles of Sedimentary basin analysis, Third Edition, Springer-Verlag, Berlin, 2000
Payton, C.E., 1977. Seismic Stratigraphy- applications to hydrocarbon exploration. Memoir of the American Association of Petroleum Geologists 26, 516pp.

Petrophysics (3 0 0 6)

Fundamentals of petrophysics. Porosity, permeability, capillary action in porous media, relative permeability, Interaction between petrophysical parameters. Borehole environment. Invasion profiles and invasion characteristics. Hydrocarbon mobility. Acquisition of petrophysical data. Data quality assurance. Presentation of petrophysical data. Measurement of natural gamma rays. Formation waters, Importance of formation water characteristics. The SP curve. Well-site log evaluation. Formation resistivities. Shallow and deep resistively measuring devices. Fluid zones and capillary pressure, capillary pressure saturation, Practical work with well log and core analysis and well pressure data.

Texts/references

Guegen, Y. and Palciauskas, V. Introduction to physics of rocks, Princeton University Press, 1994.

Tiab, D. and Donaldson, E.C. Petrophysics: theory and practice of measuring reservoir rock and fluid transport properties. Gulf Publishing Company, 1996

EN 606 (3006)

Energy Resources, Economics and Environment

Overview of World Energy Scenario: Dis-aggregation by end-use, by supply Fossil Fuel Reserves- Estimates, Duration Overview of India`s Energy Scenario- Dis-aggregation by end-use, by supply, reserves Country Energy Balance Construction- Examples. Trends in energy use patterns, energy and development linkage.

Energy Economics - Simple Payback Period, Time Value of Money, IRR, NPV, Life Cycle Costing, Cost of Saved Energy, Cost of Energy generated, Examples from energy generation and conservation, Energy Chain, Primary energy analysis Life Cycle Assessment, Net Energy Analysis.

Environmental Impacts of energy use - Air Pollution - SOx, NOx, CO, particulates Solid and Water Pollution, Formation of pollutants, measurement and controls; sources of emissions, effect of operating and design parameters on emission, control methods, Exhaust emission test, procedures, standards and legislation; environmental audits; Emission factors and inventories Global Warming, CO2 Emissions, Impacts, Mitigation Sustainability, Externalities, Future Energy Systems.

Texts/References

Energy and the Challenge of Sustainability, World energy assessment, UNDP, New York, 2000.

AKN Reddy, RH Williams, TB Johansson, Energy after Rio, Prospects and challenges, UNDP, United Nations Publications, New York, 1997.

Global energy perspectives / edited by Nebojsa Nakicenovic, Arnulf Grubler and Alan McDonald Cambridge University Press, 1998

Fowler, J.M., Energy and the environment, 2nd Edn., McGraw Hill, New York, 1984.