University of Pune

Two Year M. Sc. (Applied) Degree Course in

PETROLEUM TECHNOLOGY

M.Sc. Part I Syllabus

(To be implemented from Academic Year 2013-14)

Structure of syllabus: Basic structure/pattern (Framework) of the proposed postgraduate syllabus for the two year integrated course leading to M.Sc. Petroleum Technology (Applied) in the colleges affiliated to Pune University with medium of instructions being English.

1. Credit based Syllabus of M.Sc. Petroleum Technology (Proposed from July 2013)

2. Preamble of the syllabus

i) Master's degree course in Petroleum Technology would be of 100 credits, where one credit course of theory will be of one clock hour per week running for 15 weeks and one credit for practical course will consist of 15 of laboratory exercise.

ii) Student will have to take admission in Petroleum Technology Department of the affiliated college and complete 75 credits incorporated in the syllabus structure of Petroleum Technology. The remaining 25 credits shall be chosen from courses offered by the Petroleum Technology Department or other Departments of the University and affiliated colleges with credit system structure.

iii) Two credits, one each in four semesters, have been allocated for Field work and Project work components. Of these, Field work component will be covered during 1st and 2nd semesters, while Project work component, during 3rd and 4th semesters, respectively.

iv) Every student shall complete 100 credits in a minimum of four semesters. All Semesters will have 25 credits each.

v) Academic calendar showing dates of commencement and end of teaching, internal assessment tests and term end examination will be prepared and duly notified before commencement of each semester every year.

3. Terms and Conditions

The students seeking admission to M.Sc. (Applied) Petroleum Technology course are hereby informed that they are supposed to adhere to the following rules:

i) A minimum of 80 % attendance for lectures / practicals is the pre-requisite for Grant of Terms.

ii) There shall be 28 tutorial / practical tests as a part of internal assessment in each semester. The students are supposed to attend all the tests as per the timetable. The students should note that re-test will not be given to the student absent for the test/s.

iii) The students opting for dissertation course shall follow the rules framed for the same.

iv) To conduct optional theory credit courses minimum number of students required is eight.

v) Fieldwork is a compulsory component of the syllabi. The students are supposed to attend all the field tours / Project work organized by the department from time to time for course nos. FWPWC-1, FWPWC-2,

FWPWC-3 & FWPWC-4. The students shall attend the tours at their own cost and risk.

vi) The students are requested not to encourage friends to visit the department during working hours.

vii) The students are supposed to read the notices placed on various notice boards to keep the track of the academic and administrative activities.

4. Eligibility:- Student should be a Science graduate with Geology as the principal subject and he/she must have offered Mathematics as the one of the subjects till 12th Standard.

OR

Students should have B.Sc. (General) degree with Geology as one of the Subsidiary subjects and he must have offered Mathematics as the one of the subjects till 12th Standard.

5. Examination Rules

i. Assessment shall consist of a) In-semester continuous assessment and b) end semester assessment. Both shall have an equal weightage of 50% each**.**

ii. The teacher concerned shall announce the units for which each in-semester assessment will take place. However, the end-semester assessment shall cover the entire syllabus prescribed for the course.

iii. An in-semester assessment of 50% marks should be continuous and at least two tests should be conducted for full course of 4 credits and a teacher must select a variety of procedures for examination such as:

a. Written Test and / or Mid Term Test (not more than one or two of each course)
b. Term Paper
c. Journal/Lecture/Library notes
d. Seminar presentation
e. Short quizzes
f. Assignments
g. Extension work
h. An open book test (with the concerned teacher deciding what books are to be allow for this purpose)
i. Mini Research Project by individual student or group of students

The concern teacher in consultation with the Head of the PG Department shall decide the nature of questions for the Unit Test.

iv. Semester and examination for remaining 50% marks will be conducted by the University of Pune.

v. The student has to obtain 40% marks in the combined examination of In Semester assessment and Semester-End assessment with a minimum passing of 30% in both these separately.

vi. To pass the degree course, a student shall have to get minimum aggregate 40% marks (E and above on grade point scale) in each course.

vii. If a student misses an internal examination he/she will have a second chance with permission of the Principal in consultation with the concern teacher. Such a second chance shall not be the right of the student.

viii. Internal marks will not change. A student can not repeat Internal Assessment. In case he/she want to repeat internal assessment she/he can do so only by registering for the said courses during the 5th / 6th semester and onwards up to 8th semester.

ix. Students who have failed semester-end exam may reappear for the semester-end examination only twice in subsequent period. The student will be finally declared as failed if she/he does not pass in all credits within a total period of four years. After that, such student will have to seek fresh admission as per the admission rules prevailing at that time.

x. A student cannot register for third semester, if she/ he fails to complete 50% credits of the total credits expected to be ordinarily completed within two semesters.

xi. There shall be Revaluation of the answer scripts of Semester-End examination but not of internal assessment papers as per Ordinance no. 134 A & B.

xii. While marks will be given for all examinations, they will be converted into grades. The semester end grade sheets will have only grades and final grade sheets and transcripts shall have grade points average and total percentage of marks (up to two decimal points). The final grade sheet also indicates the PG Centre to which the candidate belongs.

xiii. **Practical Courses**: Practical courses will be evaluated on the basis of each practical. For practical course of 2 credits, 14 practicals will be conducted, there will be two practical tests of 10 marks each and 5 marks will be given for attendance and journal completion.

xiv. **Field Work and Project work Components**: Four credits, based on field work component (during 1st and 2nd semesters) and project work component (during 3rd and 4th semesters), one in each semester, will constitute the compulsory part. There will be a continuous evaluation of the field work and project work components. The evaluation will be based on following four heads:

Heads	**Marks**	**Evaluating Authority**
Performance of the student in the field / project	5	by faculty members involved in conducting tour / examiner evaluating the project
Punctuality, enthusiasm, and aptitude of students while completing the report	5	by faculty / examiner at the project place
Tour / project report	10	By committee / Examiner at the project place
Viva-voce	5	By committee

The assessment of the Field work component will be done at the end of the 2nd semester; and the assessment of the Project work component will be done at the end

of the 4th semester. The final grades for both the components will be awarded as 4 credits at the end of the 4th semester.

A) Assessment of Grade point average:
Exam Rules:

1. The system of evaluation will be as follows: Each assignment / test will be evaluated in terms of grades. The grades for separate assignments and the final (semester-end) examination will be added together and then converted into a grade and later a grade point average. Result will be declared for each semester and the final examination will give total grades and grade point average.
2. Marks/Grade/Grade Points

Marks	Grade	Grade Point
100 to 75	O : Outstanding	06
74 to 65	A : Very Good	05
64 to 55	B : Good	04
54 to 50	C : Average	03
49 to 45	D : Satisfactory	02
44 to 40	E : Pass	01
39 to 0	F : Fail	00

3. Final Grade Point

Grade Point	Grade
05.00-06.00	O
04.50-04.99	A
03.50-04.49	B
02.50-03.49	C
01.50-02.49	D
00.50-01.49	E
00.00-00.49	F

4. The formula for GPA will be based on Weighted Average. The final GPA will not be printed unless a student passes courses equivalent to minimum 100 credits, 80 credits or 64 credits as the case may be.
5. (i) Semester Grade Point Average(SGPA)=

$$SPGA = \frac{\sum_{i=1}^{p} Ci\ Gi}{\sum_{i=1}^{p} Ci}$$

$$SPGA = \frac{\sum \text{Grade Point Earned} \times \text{Credits for each course}}{\text{Total Credits}}$$

(ii) Cumulative Grade Point Average (CGPA) =

$$CPGA = \frac{\sum_{i=1}^{p} Ci\ Gi}{\sum_{z=1}^{p} Ci}$$

$$CPGA = \frac{\sum \text{Total Point Earned} \times \text{Credits for each course}}{\text{Total Credits}}$$

6. 'B' Grade is equivalent to atleast 55% of the marks as per circular No. UGC-1298/ [4619] UNI-4 Dated December 11,1999.
7. A seven point grade system [guided by the Government of Maharashtra Resolution No. NGV-1298/[4619]UNI-4 Dated December 11,1999 and the University regulations] will he followed uniformly for Science, Arts, Mental, Moral and Social Sciences. The corresponding grade table is detailed in II. 14 above.
8. If the GPA is higher than the indicated upper limit in the three decimal digit, then the student be awarded higher final grade (e.g. a student getting GPA of 4.492 may be awarded 'A'.
9. There will be only final compilation and moderation at GPA (Final) level done at the Department. While declaring the result, the exiting relevant ordinances are applicable. There is also a provision for verification and revaluation In case of verification, the existing rules will be applicable. The revaluation result will adopted if there is a change of at least 10% marks and in the grade of the course.
10. For grade improvement a student must reappear for semester-end examination for a minimum 30 credits in case of Science , 20 credits in case of faculties other than Sciences and 12 credits in case of one year degree programmes. These courses will be from will be from parent department. Grade Improvement programme will be implemented at the end of the academic year. A student can opt for the grade improvement programme only after the declaration of final semester (i.e. at the end of the next academic year after passing the M.A./ M.Sc. examination and within two years of completion of M.A./ M.Sc. and only once.
11. The description for each of the grades will be as follows.

Grades Proposed Norms

O: Outstanding : Excellent analysis of the topic, (75% and above)
Accurate knowledge of the primary material, wide range of reading logical development of ideas, originality in approaching the subject, Neat and systematic organization of content, elegent and lucidstyl;
A: Very Good : Excellent analysis of the topic, (65% and 74%)
Accurate knowledge of the primary material, acquaintance with seminal publications, logical development of ideas, neat and systematic organization of content, effective and clear expression;
B: Good: Good Analysis and treatment of the topic (55 to 64%)
Basic knowledge of the primary material, logical development of ideas, neat and systematic organization of content, effective and clear expression;
C: Average: Some important points covered (50 to 54%)
Basic knowledge of the primary material, logical development of ideas, neat and systematic organization of content, effective and clear expression;
D: Satisfactory : Some points discussed (45 to 49%)
Basic knowledge of the primary material, some organization, acceptable language or expression;
E: Pass: Any two of the above (40 to 44%)
F: Fail: None of the above (0 to 39%)

E) External Students: External students are not admitted for this course.

F) Setting of question paper/ Pattern of question paper:

Paper setting and assessment for a particular course would be the responsibility of the course In-charge, and these activities would be coordinated by the Department Examination Committee. The Department Examination committee would undertake preparation of the result-sheets for the students.

The question paper of 50 marks will consist of seven questions, out of which students will solve five questions. Two questions, one long answer question and one short note question will be compulsory.

6) M.Sc. Petroleum Technology - Course structure & Credit Distribution.

Semester I : (All courses compulsory)
PT-1: Fundamentals of Petroleum Geology (4 Credits)
PT-2: Principles of Sedimentology and Stratigraphy (4 Credits)
PT-3: Micropalaeontology in Hydrocarbon Exploration (4 Credits)
PT-4: Structural Techniques in Petroleum Exploration (4 Credits)
PTP-1: Practical (4 Credits)
PTP-2 : Practical (4 Credits)
FWPWC-1- Field work and Project work Component - (1 credit)

Semester II:
PT-5: Fundamentals of Petroleum Geochemistry (4 Credits)
PT-6: Depositional System Analysis and Petroliferous Basins of India (4 Credits)
PT-7: Geophysical and Other Methods for Petroleum Exploration (4 Credits)
PT-8: Environment Management and Economics (4 Credits)
PTP-3: Practical (4 Credits)
PTP-4: Practical (4 Credits)
FWPWC-2- Field work and Project work Component - (1 credit)

Semester III:
PT-9: Reservoir Dynamics (4 Credits)
PT-10: Formation Evaluation I (4 Credits)
PT-11: Drilling and Well Completions (4 Credits)
PT-12: Production Operations I (4 Credits)
PTP-5: Practical (4 Credits)
PTP-6: Practical (4 Credits)
FWPWC-3 -Field work and Project work Component - (1 credit)
Semester IV:
PT-13: Reservoir Performance (4 Credits)
PT-14: Formation Evaluation II (4 Credits)
PT-15: Production Operations II (4 credits)
PT-16: Mud Logging and Mud Engineering (4 Credits)
PTP-7: Practical (4 Credits)
PTP-8: Practical (4 Credits)
FWPWC-4 -Field work and Project work Component - (1 credit)

- **Medium of Instruction is ENGLISH**

7. Equivalence of previous syllabus along with proposed syllabus.

EQUIVALENCE

SEMISTER	PRESENT COURSE		PROPOSED COURSE	
	COURSE CODE	**COURSE NAME**	**COURSE CODE**	**COURSE NAME**
I	PT-1	Fundamentals of Petroleum Geology	PT-1	Fundamentals of Petroleum Geology
	PT-2	Principles of Sedimentology	PT-2	Principles of Sedimentology and Stratigraphy
	PT-3	Interpretative Micropalaeontology & Stratigraphy	PT-3	Micropalaeontology in Hydrocarbon Exploration
	PT-4	Structural Techniques in Petroleum Exploration	PT-4	Structural Techniques in Petroleum Exploration
	PTP 1	Practicals related to Petroleum Geology & Sedimentology	PTP - 1	Practicals related to Petroleum Geology & Sedimentology
	PTP - 2	Practicals related to Micropalaeontology & Stratigraphy & Structural Techniques in Petroleum Exploration	PTP - 2	Practicals related to Micropalaeontology & Stratigraphy & Structural Techniques in Petroleum Exploration
	-	--	FWPWC-1	Field work Component
II	PT-5	Fundamentals of Petroleum Geochemistry	PT-5	Fundamentals of Petroleum Geochemistry
	PT-6	Depositional System Analysis and Petroliferous Basins of India	PT-6	Depositional System Analysis and Petroliferous Basins of India
	PT-7	Petroleum Exploration	PT-7	Geophysical and Other Methods for Petroleum Exploration
	PT-8	Environment Management and Economics	PT-8	Environment Management and Economics
	PTP - 3	Practicals related to Petroleum Geology & Sedimentology	PTP-3	Practicals related to Petroleum Geochemistry & Depositional System Analysis and Petroliferous

				Basins of India
	PTP-4	Practicals related to theory courses	PTP-4	Practicals related to Geophysical and Other Methods for Petroleum Exploration and Environment Management and Economics
	-	--	FWPWC-2	Field work Component
III	PT-9	Reservoir Dynamics	PT-9	Reservoir Dynamics
	PT-10	Formation Evaluation I	PT-10	Formation Evaluation I
	PT-11	Drilling and Well Completions	PT-11	Drilling and Well Completions
	PT-12	Computer Fundamentals and Applications	PT-12	Production Operations I
	PTP-5	Practicals related to theory courses	PTP-5	Practicals related to Reservoir Dynamics and Formation Evaluation I
	PTP-6	Practicals related to theory courses	PTP-6	Practicals related to Drilling and Well Completions and Production Operations I
	-	--	FWPWC-3	Project work Component
IV	PT-13	Reservoir Performance	PT-13	Reservoir Performance
	PT-14	Formation Evaluation II	PT-14	Formation Evaluation II
	PT-15	Production Operations I &II	PT-15	Production Operations II
	PT-16	PTP-5	PT-16	Mud Logging and Mud Engineering
	PTP-7	Practicals related to theory courses	PTP-7	Practicals related to Reservoir Performance and Formation Evaluation II
	PTP-8	Practicals related to theory courses	PTP-8	Practicals related to Production Operations II and Mud Logging and Mud Engineering
	-	--	FWPWC-4	Project work Component

8. University Terms- Date of commencement and end of teaching will be notified before the commencement of each semester every year.

9. Qualification of Teacher: - NET/SET qualified candidate with M.Sc. degree in Petroleum Technology / Petroleum Geology /Geophysics. Other Criteria as per the guidelines laid down by the UGC and University of Pune.

Course wise Syllabus and Recommended books

SEMESTER –I

PT- 1 Fundamentals of Petroleum Geology (4 Credits)

UNITS	TOPICS	NO. OF LECTURES

Unit 1. Introduction: **15**

Petroleum: A Natural Resource; Historical Overview of Search for Petroleum. Definition and Relation of Petroleum Geology to other Sciences. Exploration: Role of Geosciences. Major challenges for petroleum geology and its significance in different phases of Exploration and Production.

Occurrence of Petroleum: Surface manifestation:

Surface indications and direct detection of hydrocarbons. Modes of surface and subsurface occurrence. Factors controlling the occurrences of petroleum. Unconventional resources of Hydrocarbons : Gas Hydrates, Shale Gas, Basin Centric Gas, Coal Bed Methane, Tight Gas Sands.

Unit 2. Origin of Crude Oil and Natural Gas: **15**

Origin of Petroleum: Theories of Organic and Inorganic origin. Source Rock concept. Kerogen: Source Material and Formation, Composition and Distribution. Oil window concept.

Migration and accumulation of Oil and Natural Gas:

Primary and Secondary Migration. Trapping Mechanism and formation of Oil and Gas Fields: Types of trapping mechanism (Structural, Stratigraphy and Fluid Traps). Traps associated with Salt domes.

Unit 3. Reservoir Rocks: **15**

Classification, Nomenclature, Fragmental Reservoir Rocks, Sandstone, Carbonate, Fractured Reservoir rocks and Miscellaneous.

Unit 4. Reservoir Fluids: **15**

Water, Oil and Gas and their distribution in Reservoir. Classification of Oil Field Waters and their characters. Important constituents of Oil and Gas. Porosity and Permeability: Types, Origin and geological Factors influencing Porosity and Permeabilty. Imbibation and Wettabilty, Capillarity, Displacement Pressure and Relative Permeability

Distribution of oil and Gas :

Geographic and Stratigraphic distribution of Oil and Gas. An Overview of Global and Indian Petroleum Industry.

Total number of Lectures **60**

PT- 2 -Principles of Sedimentology and Stratigraphy (4Credits)

Unit 1. A] Introduction to Sedimentology: **15**

Sedimentology and earth cycling. A brief history and Application in Petroleum Exploration

B] Sediment transport by fluid motion:

Fluid properties & fluid motion: a) Physical properties of fluid **b)** Stokes law **c)** Reynolds number & Froude number **d)** Laminar & Turbulent flow

Modes of transportation of sediment grains:

Sediment gravity flows: a) Grain flows, Debris flows, Liquefied flows & Turbidity flows **b)** Deposits of sediment gravity flows

C] Terrigenous clastic sediments:

a) Clastic grains & identification of parental rocks
b) Classification of sediments and sedimentary rocks
c) Gravel and conglomerate
d) Sand and sandstone
e) Clay, silt and mudrock
f) Textures and analysis of terrigenous clastic sedimentary rocks

D] Biogenic, Chemical and Volcanogenic sediments:

a) Limestone
b) Evaporite minerals
c) Cherts
d) Sedimentary phosphates
e) Sedimentary ironstone
f) Carbonaceous (organic) deposits
g) Volcaniclastic sedimentary rocks

Unit 2. Hydrodynamics of Depositional Environments: 15

Sedimentary Environments - Erosional & Depositional.

Outline of recognition / reconstruction of ancient depositional environments.

Limitations of reconstruction of ancient depositional environments.

Importance of inorganic primary sedimentary structures & sedimentary textures in interpretation of hydrodynamic conditions of depositional environments.

Sediment grain movement & modes of sediment transport.

Hydrodynamic factors & Bed forms in water:

a) Concept of flow regime
b) Classification & characteristics of Flow regimes
c) Bed forms characterizing different flow regimes
d) Study of following bed forms based on their morphology, internal structures, genetic classification, genesis & phase diagrams:
i) Plane bed phase ii) Small ripples iii) Mega ripples iv) Giant ripples v) Antidunes vi) Sandwaves vii) Symmetrical & Asymmetrical wave ripples viii) Current ripples ix) Combined current / wave ripples x) Isolated ripples xi) Wind ripples
e) Bed load transport: i)Migration of bed forms ii)Bed forms in relation with stream power & water depth iii) Depth-velocity-size diagram
f) Bed forms caused by erosion of cohesive sediments: i) Water erosion of cohesive beds ii) Erosion by 'tools'
g) Biogenic & organo-sedimentary structures: i) Stromatolites ii) Trace fossils &

rates of deposition

h) Diagenetic (soft sediment) deformation structures:
i) Reduction of sediment strength ii) Liquefaction & water escape structures iii) Liquefaction & current drag structures iv) Diapirism & differential loading structures v) Slides, growth faults & slumps vi) Desiccation & syneresis shrinkage structures

i) Bedding types:
i) Cross bedding ii) Climbing ripple lamination iii) Flaser & Lenticular bedding iv) Graded bedding.

Unit 3. A] Diagenesis: **15**

a) Diagenetic processes
b) Clastic diagenesis
c) Carbonate diagenesis

B] (I) Sedimentary Environments:

a) Concept of Sedimentary Environment
b) Classifications of Sedimentary Environments
c) Study of Sedimentary Environments based on physical, chemical, biological & geomorphic variables:

i) Continental / Non-marine-Desert, Alluvial fans, Fluvial, Lacustrine &Glacial
ii) Transitional-Delta, Estuarine, Beach & Clastic shelves
iii) Marine-Continental shelf, slope, Abyssal plains & Pelagic

(II)Techniques of Environmental interpretation:
Sedimentary Environments & Sedimentary Facies:
Relationship between Sedimentary Environments & Sedimentary Facies (Walther's law) Methods of Environmental diagnosis:
Data acquition & interpretation:
1. Surface Environmental interpretation
Field sedimentology & Outcrop analysis) based on:
a) Geometry b) Lithology c) Syn-pre & post depositional structures
d) Palaeocurrent patterns e) Fossils
2. Subsurface Environmental interpretation based on:
a) Core description b) Vertical grainsize profile from geophysical log P & gamma logs) c) Use of dipmeter in subsurface facies analysis.

C] Chemical, mineralogical & biological parameters making depositional environments:

a) Oxidation-reduction potential.
b) Acidity-alkalinity (pH).
c) Salinity.
d) Temperature.
e) Index minerals.
f) Colour.

g) Trace elements.
h) Outline of biological parameters.

D] Importance of sequence in environmental reconstruction:

Unit 4. A] Introduction: **15**

Evolution, scope and Importance of Stratigraphy

Standard Stratigraphic Classification and Nomencalture:

IUGS Classification

B] Elements of Stratigraphy with their Units

Description of Each Unit:

a) ChronoStratigraphy: b) LithoStratigraphy; c) BioStratigraphy;
d) Magneto Stratigraphy; e) Chemo Startigraphy; f) Sequence Stratigraphy; g) Seismic Stratigraphy;

Stratigraphic Proceedures:

Outcrop and Sub Surface Proceedures;

Stratigraphic Correlation:

Types; Evidence; Inter and Intra Basinal correlation;

C] Facies Concept and Lateral Variation:

Litho Facies, Bio Facies; Lateral Variation with Examples:

D] Geo Tectonic Classification and Distribution of Petroliferous Basins in Geological Time with tectonic set up, statistics environments and trap of each era. Study of Indian Sedimentary Basins with Classification and Examples.

Total number of Lectures **60**

PT- 3- <u>Micropalaeontology in Hydrocarbon Exploration</u> **<u>(4 Credits)</u>**

Unit 1 a) Definition, Scope, branches and applications of Micropaleontology **15**

Types of Microfossils, their size, characters and range. Uses of Microfossils in geological operations, Study of selected groups of microfossils; Foraminifera and Ostracoda

b) Types pf Micro Fossils :Their morphology,ecology and range and utility

Brief Study of Acritarchs,Tasmanitids,Spores,Pollens,Silicoflagellates, Diatoms,Coccoliths,Dinoflagellates,Tintinnids &Calpionellids,Radiolarians,Conodonts,Sponge Spicules;

c) Uses Of Microfossils: In Petroleum Exploration with examples.

Unit 2. Study of Foraminifera: **15**

Taxonomy, Structure of Living Foraminifera Cell Size, Culture; Test: Wall**.** Structure & Composition ,Chamber Development, Chamber Architecture & Shape ,

Apertures & Foramina Sculpture ,Test Function.Identification Of Environment-Fresh Water,Brackish Water,Marsh,Estuarine,Lagoonal,Bay,Oceanic .Forominiferal

Ecology:(Physical,Chemical,BiologicalCharacters,Food,Predation,Substrate,Light, Temp , Oxygen,Salinity,$CaCO_3$.)Statistical Treatment-Species Index, Specific Diversity, Diversity, Index, Cluster Analysis, Value of Alpha. Palaeoecological & Palaeoenvironmental Studies-: P/B Ratio, Nature of the shell,Planktic Forams,% of Calcareous Foram , Symbiont Larger Forams; Brief outline of High resolution Stratigraphy. Biostratigraphic Significance in: Zones, RangeZones, Acme Zones, Lineage Zones. D.S.D.P-: Brief out line Classification By Loeblich & Tappan (1987) up to level of Sub Orders: Distribution In Geological Time (General History Of Foraminifera) Applications Of Foraminifera-: (Biostratigraphy,Age,Environment, In Oil Exploration)

Unit 3. Study of Ostracoda: 15

1. Taxonomy-
2. Characters-Size, Locomotion, Environment & Mode of Life, Morphology: Wall Structure, Hinge Structure, Ornamentation & Surface Texture, Orientation of Carapace.
3. Classification
4. Identification of Environment-(Fresh Water, Brackish & Marine Environment)
5. Ecology-(Food, Substrate, Salinity, Depth, Temp.)
6. Biostratigraphic Significance
7. Use of Ostracods in Oil Exploration

Unit 4 Palynology and Biostratigraphy of Petroliferous Basins of India: 15

Morphology of Pollens & Spores; Importance in Biostratigraphy. Source Rock Potential & Thermal maturation Study, Significance of Palynodebries Data for Palaeoenvironmental Analysis. **Biostratigraphy Of Petroliferous Basins Of India With Reference to Forams And Ostracod: 1.**Cambay Basin, 2.Bombay Offshore Basin, 3.Cauvery Basin, 4.Krishna-Godaveri Basin, 5.Assam-Arakan Basin, 6.Jaisalmer Basin

Total number of Lectures 60

PT- 4 <u>Structural Techniques in Petroleum Exploration</u> <u>(4 Credits)</u>

Unit 1. Introduction: 15

a) Uses and value of Structural Geology to Petroleum Geologist.

b) Development of Structural Geology / Structural data: i) Collection of field data ii) Developing generalizations iii) Testing of theories

c) Scope of Structural Geology

d) Qualifications and duties of Structural Geologist or Structural work of Petroleum Geologist.

Application of structural data and techniques in discovery and Development of oil and gas fields:

a) Relative importance of structural data
b) Practical consideration in wildcatting: Economic aspect of the structures
c) Chances of finding oil production on untested traps.
d) Nonstructural factors
e) Regional structural conditions:
i) Regional structural conditions affecting the prospects for production in a structural trap. ii) Significance of position iii) Regional alterations-causes and structural significance of physical and chemical changes during regional alterations of the sediments iv) Local structural conditions v) Oil and gas production in relation to closure and closed areas of folds h) Closure and thickness of productive zone i) Factors affecting prospects for production on local structural traps j) Difficulty in finding trap of oil / gas accumulation k) Mental factors in wildcatting.

Unit 2. Classification and study of traps for oil and gas accumulation: 15

a) Definition and essential elements of a trap b) Stratigraphic relations of structural traps c) Traps on closed anticlines d) Effect of possible escape of oil and gas through faults e) Closure and closed area of faulted structures f) Closure against faults g) Assumptions about imperviousness of fault planes h) Closure of anticline bounded by faults on up dip side i) Closures produced by intersecting faults j) Stratigraphic control of the sealing of fault traps k) Formation of trap in relation with movement of up dip fault block l) Relations of lithologic variations in a reservoir to closure and closed m)Types of traps and their definitions n) Classification of traps of oil and gas accumulation o) Regional variations in types of traps p) Traps in relation to age and lithology of rocks q) Cover rocks.

Maps and Cross sections:

a) Importance of maps and cross sections in Petroleum Geology
b) General characteristics of maps
c) Characteristics of following maps:
i) Base maps
ii) Topographic maps
iii) Photo geological maps
iv) Geologic and areal maps
v) Palaeogeologic and palaeoareal maps
vi) Palinspastic maps
vii) Equal value maps
viii) Structure contour maps
ix) Reconnaissance and details maps
d) Structural contouring-inter conversions of structure contours and dip-strike readings .
e) Phantom horizons

f) Representation of uncertain structures .
g) Strike lines and form lines .
h) Construction of uncertain structures .
i) Construction of isopach maps.
j) Construction, interpretation and use of cross sections .
k) Three dimensional models, block diagrams and their use.
l) Graphical determination of attitude of formations .

Unit 3. Folds **15**

a) Mechanical adjustments during folding of sedimentary formations: i) Slippage ii) Flowage-Drag folds: mechanism of formation and use of drag folds in determination of major structure

b) Competent and incompetent rocks c) Method to calculate depth of folding-principle, assumptions and limitations of the method d) Characteristics of folds important to petroleum geologist: i) Closure ii) Cross folding and multiple axes in relation to closure and closed area

iii) Reversal iv) Character of anticline after subtracting regional dip v) Determination of dips of axial plane and crestal plane vi) Change in size of folds with depth e) Recognition and representation of folds f) Office techniques in study of folds: i) Equal area and stereographic projections ii) Pi diagrams iii) Contour diagrams iv) Beta diagrams

g) Use of computers in preparing Pi and Beta diagrams

Faults: a) Surface recognition of faults: i) Alignments ii) Offsets / displacements iii)Topographic expressions iv) Valleys and ridges along faults v) Distinguishing fault scarps and erosional scarps or escarpments vi) Scarps-Tectonic or fault scarps, Erosional scarps or Fault line scarps (resequent and obsequent scarps) vii)Expression on Areal maps viii)Expression on Air plane photographs ix) Expression on Structure contour maps and on isopach maps.

b) Recognition of Subsurface faults: i) Strata higher or lower than expected ii) Abnormal intervals iii) Omission and repetition of strata c) Determination of movements along faults

d) Reversals due to faulting e) Origin of Enechelon folds and faults f) Relation of faults and folds to basement structure g) Relations of oil and gas fields to faults.

Joints and fractures:

a) Importance of joints and fractures of reservoir rocks in petroleum geology

b) Geological relations of joints their uses: i) Relation to stress ii) Relation to regional alterations iii) Relation to local structures iv)Relation to regional structures

c) Role of joints and fractures in migration of oil and gas: i) Economic importance-Fractures as reservoir rocks ii) Stratigraphic conditions favoring production iii) Oil and gas production from basement rocks iv) Structural conditions favoring production :

Characteristics of oil and gas production: determining nature of reservoir, significance of lithology, lithologic nature of reservoirs, production from both fractures and pores, characteristics of fracture production, pressure differences and interferences, rate of decline and estimating recovery

Unconformities: a) Stratigraphic and structural relations at the unconformities: i) Truncation ii) Overlap iii) Onlap iv) Offlap v) Transgression vi) Regression

b) Recognition of unconformities at the surface and on areal maps c) Recognition of subsurface unconformities d) Effects of unconformities on oil and gas prospects.

Unit :4 Salt domes: 15

a) Definition, importance, value, geographic distribution and classification of salt domes b) Salt stalk, overhang and source salt layer c) Marginal upturning and uplift d) Rim synclines, cap rock and false cap (origin) e) Faulting associated with salt domes f) Topographic / geologic expressions and surface indications of salt domes g) Salt structures h) Piercement and Non Piercement salt domes i) Salt anticlines, salt ridges, residual highs and anticlines on downthrown side of fault j) Salt domes associated with compressional folds k) Model studies of salt domes l) Time of formation m) Origin of salt domes: i) Role of compression and bouncy, distinguishing features ii) Mechanism of salt dome emplacement n) Central subsidence, shapes of salt domes and mutual relation o) Oil and gas production from salt domes

Oil and gas fields associated with buried hills:

a) Traps within buried hills b) Traps in sediments around buried hills c) Traps over buried hills d) Buried hills and recurrent folds e) Production from traps associated with buried hills.

Total number of Lectures 60

(PTP-I) PRACTICALS RELATED TO PT-1 and PT-2 (4 Credits)

Unit :1- PETROLEUM GEOLOGY

1. Determination of bulk porosity of reservoir rock with single pan balance.
2) Determination of shale factor of a reservoir rock.
3) Estimation of optical activity of an organic compound.
4) Determination of refractive index of an organic compound using Abbey's refractometer.
5) Isopach maps and Panel diagrams.
6) Uses of Computer in Pertoleum Geology.

Unit :2 - Sedimentology and Stratigraphy

Sedimentology

1) Megascopic study of the clastic and non clastic rocks with genetic significance.
2) Microscopic study of the clastic and non clastic rocks with genetic significance.
3) Study of sedimentary structures with their environmental significance.
4) Study of core samples.
5) Identification and Implication of Heavy minerals.
6) Calculation of moment measure.
7) Palaeo–environmental Interpretation.

8) Quantitative method of estimation of roundness by weadle's method.
9) Uses of Computer in Sedimentology and Stratigraphy.

Stratigraphy

Exercises based on Correlation, Lithological and Palaeontological. **Environmental studies.**

Identification of environments with RTM suborders of foraminifer.

Sedimentary basins of India, brief Lithological, Structural and Palaeontological descriptions.

(PTP-2) PRACTICALS RELATED TO PT-3 and PT-4 (4 Credits)

Unit :1 - MICROPALAENTOLOGY

Separation of Micro Fossils from the Matrix of sedimentary rocks. (Lab techniques)

Separation of Micro Fossils from:-

(1) Shale.
(2) Clay Stones.
(3) Limestones.
(4) Chert - Dolomite.
(5) Coal – Shales for Pollens & Spores.

Seperation, picking & mounting of microfollils:

(1) Accessory required – Types of Microfaunal Slides.
(2) Hand Picking Method – Mounting of Microfossils.

Foraminifera

(1) General Morphology, Coiling, Arrangement of Chambers, Ornamentation.
(2) Study of Selected Genera of Foraminifera with Reference to:-
Classification, Description, Composition, Distribution (Environmental & Geological), Distinguishing Features of following selected genera.
(a) Nodosarides (Lagena & others), (b) Bolivina, (c) Ammonia, (d) Elphidium, (e) Quinqueloculina, (f) Globorotalia, (g) Globogerina, (h) Textularia.

Ostracode

(a) General Morphology & Orientation of Carapace.
(b) Candona –Morphology, Composition, Distribution (Environmental & Geological)
(c) Any other identified genus.

Radiolarians –

Morphology, Composition, Distribution (Environmental & Geological)

Pollens, Spores: - Morphology, Stain Test, Distribution.

Uses of Computer in Micropalaeontology.

Unit :2 - Structural Techniques in Petroleum Exploration

I) Application of technique of descriptive geometry in solving structural problems:

1) Problems involving altitudes / depths of exposures of top & bottom bedding planes of the formation, true / apparent thickness / dip / width of outcrop & vertical thickness of the formation

2) Problems related to planar features containing linear features (single & intersecting planar features) & determination of bearing, plunge & rake of intersection in the planar features (attitude readings taken at same & at different elevations)

3) Three point problems based on drilling data

4) Vertical fault problems (with translational movements only) - Determination of net slip, relative movement & type of fault based on separation data. Locating counter part of disrupted horizon.

5) Inclined fault problems (with translational movements only) - Determination of net slip, relative movement & type of fault based on separation data. Locating counter part of disrupted horizon.

II) Using stereographic net in solving structural problems:

1) Problems involving strike, true & apparent dip of the planar features

2) Problems involving planar features containing linear feature (single & intersecting)

3) Uses of Computer in Structural Techniques in Petroleum Exploration.

FWPWC-1 : Field work Component: – (1 credit)

REFERENCE BOOKS **Name of the Authors**

PT-1

1	Geology of Petroleum	A.L.Leverson
2	Petroleum Geology	F.K.North
3	The world of Petroleum	B.G.Deshpande
	Introduction to Petroleum Geology	G.D.Hobson E.L.Tiratsoo
4	Petroleum Geology	R.E.Chapman
5	Principles of Petroleum Geology	W.L. Russle

PT-2

1	Applied Sedimentology	Selley, R.C.
2	Petrology of sedimentary rocks	Boggs, Jr.
3	Physical processes of sedimentation	Allen, J.R.L
4	Sedimentology	Chamley, H.
	Principles of sedimentology	Friedman, G.M. and Sanders, J.E.
5	Practical Sedimentology	Lewis, D.W.
6	A practical approach to sedimentology	Lindholm, R.C.
7	Sedimentary rocks (3rd ed.)	Pettijohn, F.J.
8	Sand and sandstone (2nd ed.)	Pettijohn, J.F., Potter,
9	Techniques in Sedimentology	Tucker, M. (ed.),
10	Reservoir Sandstones	Berg, R.R.
11	Carbonate Reservoirs	Moore, C. H.
12.	Sandstone Petroleum Reservoir	Barwis, J.H.
13.	Sedimentology and Stratigraphy 2nd ed	Gary Nichols
14.	Stratigraphic Principles and Practices	Weller
15.	Startigraphy and Sedimentary Rocks	Krumbein and Sloss
16.	Geological Time Scale	B. Harland
17.	Recent Researches in Qualitative Stratigraphic Correlation	F.P.Agtebero
18.	Stratigraphy of India and Burma	M.S.Krishnan
19.	History of Earth	B. Kummel
20.	Global Geological History and Distribution Of Hydrocarbon Reserves	C.Bois et.al
21.	Principles of Stratigraphic Analysis	Blart et.al
22.	An overview of Litho, Bio and Chrono Sequence Stratigraphy and Sea level changes of Indian Sedimentary Basins	D.S.N.Raju et.al
23.	Stratigraphy of Indian Petroliferous Basins	Jagdish Pandey et.al

PT-3

1. Foraminifera	J.R.Haynes
2. Marine Geology	I. P.Kennett
3. Introduction to Micro fossils	D.B.Brasier
4. Introduction to Micro Palaeontology	Daniel Jones
5. Distribution and Ecology of Living Benthic Foraminifers	J.W.Murray
6. Classification of Plant Derived Organic Matter in sediments	T.C. Masran & S.A.J.Pococa
7. Micropaleontology in Petroleum Exploration	J.R.Wynn
8. Elements of Micropaleontology	G.Bignot

9. Calcareous Algae	John Wray
10. Palynology in Hydro Carbon Exploration (India Scenario) Memoir 48 (Part 1)	Mehrotra et.al
11. Stratigraphic Principles and Practices	Weller
12. Startigraphy and Sedimentary Rocks	Krumbein and Sloss
13. Geological Time Scale	B. Harland
14. Recent Researches in Qualitative Stratigraphic Correlation	F.P.Agtebero
15. Stratigraphy of India and Burma	M.S.Krishnan
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19. An overview of Litho, Bio and Chrono Sequence Stratigraphy and Sea level changes Of Indian Sedimentary Basins	D.S.N.Raju et.al
20. Stratigraphy of Indian Petroliferous Basins	Jagdish Pandey et.al

PT-4

1. Techniques of modern Structural Geology: Folds andFractures	John G. Ramsay
2. Structural Analysis and Synthesis	Stephen M Rowland, Ernest Duebendorfer
3. Applied Subsurface Geological mapping Bischke.	Daniel Tearpock, Richard
4. Structural Geology for Petroleum Geologist	William Russell
5. Plate tectonics and Crustal evolution	Kent C. Condie
6. Aspects of tectonics-Focus on South central	K.S.Valdiya Asia
7. Structural Geology Ramsay	
8. Structural Methods for Petroleum Exploration	Badgley
9. Structural Geology for Petroleum	Russell and Badgley
10. Foundations of Structural Geology-third	Park R.G edition.

SEMISTER II

PT- 5 FUNDAMENTALS OF PETROLEUM GEOCHEMISTRY (4 Credits)

UNITS	TOPICS	NO. OF LECTURES

Unit 1. Composition: **15**

Paraffins, Cycloparaffins or Naphthenes, Aromatic Hydrocarbons, Olefin Hydrocarbons, Sulphur Compounds, Nitrogen Compounds, Oxygen Compounds, Organo-Metallic Hydrocarbons; H/C Ratio of Hydrocarbons; Kerogens: Formation, Composition and Digenesis.

Classification of Crude Oils:

Physical, Chemical and Genetic Classification of crude oil

Unit 2. Oil Fields Brines: **15**

Composition, Classification, Origin and alteration of Oil Field Brines;

Importance of Oil Field water analysis, Effects of water circulation on Hydrocarbons

Properties of Hydrocarbons:

Density, Viscosity, Surface Tension, Color, Fluorescence, Cloud Point and Pour Point, Aniline Point, Optical Properties, Flash Point, Refractive Index and Calorific Value.

Unit 3. Hydrocarbon Thermodynamics: **15**

Liquid Phase Behavior, Molecular Behavior; Changes in Phases with Changes in Pressure Temperature; Pure Hydrocarbons, Hydrocarbon Mixtures, Low Shrinkage-Gas, High

Shrinkage - Gas, Retrograde Condensate Gas, Wet and Dry Gas.

Analytical Techniques:

Quantitative and Qualitative Steps in Analysis of Petroleum; Analytical Methods in Geochemistry for Reservoir Rocks and Fluids;

Unit 4. Separation of Crude Oil: **15**

Distillation and Classification of Petroleum; First, Second and Third Generation Petrochemicals;

Miscellaneous Petrochemicals;

Petrochemical Industry in India;

Integrated Petrochemicals Complex; Use of Natural Gas as Petrochemical Feedstock; Future of Petrochemical Industries;

Total number of Lectures **60**

PT- 6

Depositional System Analysis and Petroliferous Basins of India (4 Credits)

Unit I: Introduction: 15

Basic concepts of: a) Depositional Systems, b) Sedimentary Environments, c) Sedimentary Facies, d) Sedimentary models, e) Walther's law

Fluvial models : a) Basic fluvial systems / models with their discharge characteristics, spectral dip oriented facies types b) Classification and sub facies of alluvial systems c) Depositional models of following fluvial systems:- Braided fluvial system; Coarse grained meander belt system; Fine grained meander system; Distributary channel; Confined valley fill deposits.

Unit 2: Delta models: 15

a) Definition of Delta, Stages of development of ideal delta system and morphological units of delta ; b) Progradation of delta (Mississippi, Nile and Bramhaputra delta) c) Triangular classification of deltas; d) Ancient delta deposits; e) Delta cycle: Constructional and destructional phase in delta formation; f) Delta deposition: Variables involved, High constructive and High destructive deltas; g) Fan delta model: Characteristics, tectonic setting and associated facies; h) Composition and recognition of ancient fluvial / deltaic systems; i) River dominated deltas: Elongate deltas- Example with progradation and aggradation facies; j) Lobate deltas as high constructive deltas- Example with characteristic progradation and aggradation facies; k) Marine dominated deltas: Examples, characteristics and facies of: i) Wave dominated delta; ii) Tide dominated delta; l) Recognition of ancient deltas.

Sedimentary and tectonic factors in Fluvial / Deltaic Systems

a) Effect of tectonism in sedimentary basins on fluvial / deltaic systems; b) Klemme's classification of basin types; c) Effect of tectonism on spatial arrangement of Marginal and Cratonic basins; d) Recognition of effects of tectonism on ancient delta systems; e) Contemporaneous and post depositional compaction of delta sediments as a Digenetic model in trapping of hydrocarbons.

Unit 3) Basin formation mechanisms and sedimentation: 15

a) Basin formation mechanisms: Basins due to lithospheric stretching; Basins due to flexure, Basins associated with strike slip deformation; b) Basin setting and depositional style: Depositional styles of basins related to divergent motion, convergent motion and strike slip deformation.

Strike Systems (Non deltaic coast lines): a) Barrier bars: Types and facies assemblages; b) Shore face facies: Geometry, boundary relationships and vertical sequence; c) Strandplain Systems: processes, facies and variations; d) Tidal flat

Systems: Tidal inlet processes and facies; e) Terrigenous Shelf Systems:- Structural shelf and Physiographic shelf; Shelf environment and processes; Shelf depositional models-tide dominated, wave dominated, biogenic and carbonate shelf.

Carbonate / Evaporite Shoreline / Shelf Systems and reefs Slope and Abyssal Systems: a) Status of deep water studies in construction of deep-water environment; b) Slope and Abyssal Systems: Definitions and general features; c) Depositional processes and Slope / Abyssal sediments:

Study of following processes: Traction Vs Suspension transport; Mass gravity movement; Turbidity flow and turbidites Grain and shear flow, Bottom hugging traction flow; Suspension and pelitic-pelagic deposits (Basinal / Abyssal); Contour / Geostrophic currents and contourite; Cloudy (nepheloid) suspension current; Bioturbation;

d) Brief description of processes and sediments; e) Submarine fan: Principle processes and sediments; f) Slope stratigraphic units: - Offlap, onlap and uplap; Depositional significance of slope geometry; Depositional phases: Constructional, Destructional and Repetitive

g) Conceptual Depositional models: Study of uplap, offlap and onlap Slope Systems.

Unit 4) Sequence Stratigraphy in Environmental reconstruction Seismic Stratigraphic interpretation in Petroleum Exploration:
15

a) Seismic stratigraphy

b) Seismic reflection parameters used in seismic stratigraphy and their geological significance

c) Procedures during seismic stratigraphic interpretation;

d) Recognition and discrimination of depositional sequences in seismic stratigraphic interpretation;

e) Outlines of stratigraphic interpretation of seismic facies.

Petroliferous Basins of India: Study of following petroliferous basins of India with reference to geological setting, tectonics, structure and petroleum prospects: Bombay basin; Krishna-Godavari basin; Assam basin; Cauvery basin; Rajasthan basin

Total number of Lectures **60**

PT- 7

Geophysical and Other Exploration Techniques for Petroleum Exploration (4 Credits)

Unit 1. Geological Exploration: 15

Use of aerial photographs, satellite imageries, and radar imageries in structural Or litho logical mapping for Petroleum Exploration.

Techniques of Geological Mapping: Surface and Sub Surface.

Surface Geochemistry in Petroleum Exploration:

Concepts of Micro seepage.

Methods of Micro seepage detection: **Direct vs Indirect**. Significance of following methods in Petroleum Exploration: Radiometric, Halogens, Major and Minor elements, Microbial, Helium, Ph / Eh Methods;

Unit 2: Magnetic and Gravity Methods used in Petroleum Exploration: 15

Magnetic Method:

Introduction, Magnetic field of the Earth, Magnetism of Rocks and Minerals, Instruments (Schimdt, Fluxgate, Torsion Magnetometers), Field Procedures, Reduction of Magnetic Anomaly Maps and Profiles , Airborne Magnetometers (Constructions and working principles), Interpretations, Applications in Petroleum Explorations with Indian examples**.**

Gravity Method:

Introduction, Gravitational field of the Earth, Densities of Rocks and Minerals, Measurement of Gravity (Absolute and Relative), Instruments (Pendulum measurements, Spring Gravimeters, Vibrating Spring Gravimeters), Field Procedures, Reduction of Gravity Data, Gravity Modeling (Gravity Anomalies with simple Geometrics, Models using Semi-infinite slab approximations), Gravity Anomaly Maps, Interpretations, Applications in Petroleum Explorations with Indian Examples.

Unit 3: Seismic Method: 15

General Principles, Seismology and Seismic Prospecting, Elastic Properties of rocks, refraction and Reflection of seismic waves, general scheme of Seismic Prospecting; Seismic Body Waves (Compressional, Shear, Body Waves), Refractions and Reflections of Seismic Body Waves, Rays and Wave Fronts, Wave Conversions, Snell's Law, Critical Refraction, Paths of Seismic Body Waves), Seismic Surface Waves(Raleigh and Love Waves), Waveguides, Seismograms, The source Wavelets, Geometrical Spreading and Absorption, Transmission and Reflection Coefficients, Vibrations at a Receiver, Recording Seismic Waves.

Refracted Seismic Waves and Earth Structure:

The Single- layer Refraction Problem, Critical Refraction, Preparing a Travel Time Curve, Measuring Seismic Wave Velocities, Calculating Layer Thickness, Relationships Between Intercept Time and Crossing Distance Application, Refracted Waves in Multilayered Structures, The Ray Parameter, Wave Fronts and Rays, Travel Time and

Layer Thickness, Features of Reversed Travel Time Curves, Calculating Velocity, Thickness and Dip, Application, Refraction Along a Discontinuous Boundary, Some Limitations of Seismic Refraction Survey, Static Corrections, Inspection of Travel Time Curves, The Plus – Minus Method, The Wave Front Method, Applications of Seismic Refraction Surveying.

Reflected Seismic Waves and Earth Structure:

Reflection from a Single Horizontal surface, The Reflection Travel Time Curve, Reflection Arrival Time, Normal Move – out, Measuring Velocity and Reflection Depth, reflected waves and Direct waves, Reflection from a sloping surface, Paths of Reflected Waves, Reflected Travel Time, Reflector Depth and Dip, Alternate Analysis, Three – Dimensional Dip Calculations. Reflected Waves in a Multi – Layered Structure, Average Velocities, Root- Mean- Square (RMS) Velocities, Layer Thickness and Velocity, Reflector Depth, Practical Example, Multi Reflected Waves, Diffracted Waves, Multifold Reflections.

Unit 4: Seismic Surveying: 15

Instruments for Seismic Surveying (Geophones, Hydrophones), The Seismic Cable, Marine Streamer Cables, Analog Recording Systems, Digital Recording Systems, Seismogram Displays, Impulsive Sources, Non- Impulsive Energy Source, The Seismic Crew, Field Operations, Basic Spreads, Single-Coverage Reflection Profiling, Common Depth Point(CDP) Reflection Profiling, Marine Seismic Profiling, Noise Control, Noise Problem at Sea, Vibroseis, CDP Profiling in wells, Three Dimensional Reflection Acquisition, Crooked Line Reflection Surveying.

Seismic Reflection Data Processing and Interpretation.

Total number of Lectures 60

PT- 8

Environmental Management and Economics (4 Credits)

Unit 1. Pollution Assessment & Management: 15

i) Introduction: ii) Types of Pollution: Air, Water, Soil and Noise Pollution, during Exploration, Drilling, Production, Transportation and Refining.

A) Air Pollution: i) Introduction: Concept, Sources, Types of Pollutants, Precautionary Measures, Case study of Oil Field air pollution in Upper Assam.

ii) Flaring : Definition, Diversity in Flaring, Concept of Smoke less Flare, Environmental factors associated with flaring Operations, Precautionary Measures, Case Study;

iii) Emissions: During Drilling, Production, Storage and LPG plant operations.

B) Noise Pollution:

i) Introduction: Concept, Sources, Noise standards, Effects of Noise on Human Health, Control of Noise Pollution.

C) Water Pollution:

i) Introduction: Concept, Sources, Standards and Types (Fresh water, Marine water and
Ground Water), Oil Spill (Control and Prevention), Case Study;

D) Soil Pollution: i) Introduction: Concept, Sources, Effects on Human Health and Control of Soil Pollution, Case Study;

Environmental Impact Assessment: Introduction: Concept, Environmental Impact Assessment model and its implementation. Case Study of Gandhar Oil Field and Enhanced Oil Recovery by Steam Injection;

Unit 2. Environmental Management: 15

Introduction: Concept, Environmental Management of the Offshore Oil and Gas Industry;

Unit 3. Energy Resources: 15

Introduction: Concept, Sources and World Scenario;

Economics 15

Unit 4. Prices and Market Forces: i) Introduction: Definition, nature of Economics and Economic problems. Meaning of demand and supply. ii) Concept of Elasticity of demand & supply. iii) Price determination-a general equilibrium analysis.

Production : i) Factors of production & their characteristics (land & labour); ii) Law of variable proportion; iii) Concepts of Costs, Total cost, Average cost, Marginal cost, Fixed & Variable costs;

Firms and Market: i) Introduction: Definition and types of Market (Perfect competition, Monopoly and Monopolistic competition), ii) Price determination under the above mentioned markets.

Pricing Decisions: i) Break even analysis, pricing selling cost under monopolistic competition and Profits.

Petroleum Production Economics : i) Introduction : New income projects, Present Day Value (PDV) concept, Effect of PDV on project analysis; Rate of Return; Acceleration projects, Long term capital expenditures etc. Measures of profitability; ii) Decision tree Analysis, Definition of decision node, Chance node, outcomes & probabilities, conditional monetary values and EMV; iii) Solving of decision tree & its advantages, preferences theory concept, Concept of depreciation & depletion, etc.: Drilling economics.

Risk and Uncertainty in Hydrocarbon Exploration: i) Introduction: Definition and concept

ii) Different Types: Geological, Price, Political, Macro Economic, Business, Environment and Project Risk.

Total number of Lectures **60**

(PTP-III) PRACTICALS RELATED TO PT-5 and PT-6 (4 Credits)

Unit: 1- PETROLEUM GEOCHEMISTRY

1) Determination of bulk porosity of reservoir rock with single pan balance.
2) Determination of shale factor of a reservoir rock.
3) Estimation of optical activity of an organic compound.
4) Determination of refractive index of an organic compound using Abbey's Refractometer.
5) Isopach maps.
6) Panel diagrams.
7) Surface tension of organic fluids by travelling microscope.
8) Determination of chemical composition of a binary mixture of an organic Compound with help of PH meter.
9) Use of Flame photometer and determination of sodium, potassium & calcium.
10) Use of viscometer and determination of chemical composition of unknown hydrocarbon mixture. Use of Computer in Geochemistry.

Unit: 2- Depositional System Analysis and Petroliferous Basins of India

I) Interpretation of Structure contour maps:

1) Determination of closure of folds, faults, intersecting faults & faulted structures from structure contour maps

2) Determination of reversals of structures from structure contour maps

3) Determination of order of priority to drill the various structures for oil & gas based on structure contour maps

II) Removal of regional tilt of the area & locating pre-tilt crest of the structure& determining the pre-tilt closure from the structure contour maps

III) Interpretation of Isopach maps & maps showing relations of lithological variations in reservoir to closure & closed area

IV) Geological maps & cross sections:
1) Geological maps of highly deformed strata with folds having vertical beds, inclined faults, dykes, unconformities etc

2) Description of topography & geology of the area

3) Commenting on shapes & topographic expressions of folds

4) Drawing vertical sections of the geological maps in desired directions

V) Completion of outcrop patterns with the help of given data

VI) Dip isogons:
1) Definition, drawing & significance of dip isogons

2) Ramsay's classification of folds based on stacking of folded surfaces

3) Drawing dip isogons for different Ramsay's classes of folds

4) Interpretation of dip isogon patterns for different Ramsay's classes of folds & giving their general & diagnostic characters.
Usage of Computers.

(PTP-IV) PRACTICALS RELATED TO PT-7 and PT-8 (4 Credits)

Unit: 1- Petroleum Exploration

i) Determination of True Resistivity and thickness of beds from the Resistivity data from VES.
ii) Determination of depth of ore bodies from Gravity data / Identification of sub surface structures from Bouger Anomaly Maps / Gravity data corrections.
iii) Determination of depth and orientation of dyke from vertical Magnetic intensities, by drawing a Magnetic Anomaly curve
iv) Drawing of Seismic Section from Seismic data:
a) Finding depth of refracting surveys two layers and three layers from Seismic Refraction data.
b) Computer Analysis of Seismic data.

Units: 2- Environmental Management and Economics

1) Decision tree analysis
2) Problems on production economics.

3) Problems related to air, sound, water & soil pollution.
4) Pprobability and statistical analyses involving : Probability, Distributions, Distribution parameters, Bayes theorem, Prior distributions for geological variables, Correlation and regression, Multivariate analysis, Analysis of Variance, Geostatistics (Kriging) ,Monte Carlo simulation

FWPWC-2 : Field work Component: -1 credit

REFERENCE BOOKS **Name of the Authors**

PT-5

1. An Introduction to Physics and chemistry of Petroleum — Kinghorn
2. Introduction to Petrochemicals — Sukumar Maiti
3. Geochemistry in Petroleum Exploration — D.W.Waples
4. Petroleum Geochemistry and Geology — John Hunt
5. Chemicals from Petroleum — A.L.Waddams
6. Analytical Chemistry — Day& Underwood
7. Instrumental Methods — Willard De Merit
8. Instrumental Methods of Analysis — Ewing

PT-6

1. Analysis: Principles and Applications- Instructor's manual. — Philip A. Allen, John R. B;Sc Allen
2. Sedimentary Environments: Processes, Facies and Stratigraphy — Reading H. G.
3. Sedimentary Basins: Evolution, Facies and Sediment budget.. — Gerhard Einsele
4. The three dimensional Facies architecture of Terrigenous clastic sediments. — Andrew D Miall
5. Sedimentation and Basin Analysis in siliciclastic rock sequences :1(Ige series) — Amer Geophysical Union,June 1989.
6. Salt and Sediment dynamics — Ian Lerche, Kenneth,Petersen CRC Press Aug
7. Principles of Sedimentary Basin Analysis — A.D. Miall
8. Petroleum and Basin Evaluation: Insights — D. H. Welte etal Springer. Verlag Berlin

from Petroleum Geochemistry, Geology and Basin model — and Heidelberg Gmbh and Co. K.

9. Basin Analysis and Seismic Stratigraphy — W. L. Fisher and L. F. Brown, Jr.

10. Petroliferous Basins of India — Voll,II and III, O.N.G.C.

11 Depositional Sedimentary Environments second edition,1980 — Rineck & Singh.

12 Recent Researches in Sedimentary Basins-Implications in the Exploration of Natural Resources: Proceedings of the National Symposium. — R.N.Tiwari (ed), Dehradun, Petroleum Publishers 1998.

13 Basin Analysis, Sedimentary Geology, Sedimentology. — Proceedings of 30th International GeologicalCongressVol.8

14 Two dimensional basin analysis for petroleum Exploration — Nakayama K.1987 Jan. University of South Carolina, Columbia.

15 Basin Analysis in Petroleum Exploration-A case study from Bekes Basin, Hungary. — Paul G. Teleki, Robert E. Mattck

16. Geology and Exploration of oil and gas-bearing ancient delta. — A.M.Akramkhodzhaev,etal

17. Sedimentary basins and Petroleum Geology of the Middle East (1987) — A.S. Alsharhan, AEM Nairn, Amsterdam, NEW York: Elsevier,

18. Sedimentary Basins Evolution, Facies and Sediment Budget. — Springer Verlag Einsele, G. 1992

19. "The Business of Petroleum Exploration" — (1992) by ed. Steinmetz, R. AAPG Treatise of Petroleum Geology, Handbook of Petroleum Geology.

20. "Oil and Gas Forecasting — (1990) by Lawrence J. Drew. 252 p., Oxford University Press.

21. "Computing Risk for Oil Prospects:

Principles and Programs" Harbough, J.W., J.C.Davis &

J.Wendebourg. 451 p.,
Pergamon or Elsevier. (1995)

PT-7

1. Principles and applications of Photo Geology S.N.Pandey
2. Remote sensing, Principles and Interpretation F.F.Sabins, Jr.
3. Remote sensing, and Image Interpretation T.M.Lillesand and R.W.Kiefer
4. Surface Geochemistry in Petroleum Exploration S.A.Tedesco
5. Whole Earth Geo Physics Robert J. Lillie
6. Basic Exploration Geo Physics Edwin S. Robbinson et.al
7. Applied Geo Physics Telford et.al
8. Introduction to Geo physical Prospecting Dobrin and Savit
9. Petroleum Exploration and Exploration Practices Bhagwan Sahey

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Sr.No	Reference Books	Name of Author
1	Environmental Management In Petroleum Industry	Wahi, Agnihotri and Sharma
2	Environment Technology in The Oil Industry	S.T.Orszulik
3	Principles of Ecology	P.S.Varma and V.K.Agarwal
4	Fundamentals of Ecology	Engene. P. Odum
5	Environmental Impact of The Offshore Oil and Gas Industry	Stanislav Patin
6	Concept of Ecology	Edward. J. Kormondy
7	Environmentally Safe Drilling Practices (Manual)	Pennwell Books
8	Text Book of Environmental Studies	Barucha E
9	Decision Analysis for Petroleum exploration	Paaul Newendorp and John Schuyler
10	Petroleum Economics and Engineering	Abdel Al, H. K, Bakr, A.B, Al – Sahlawi, M.A.
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12	New Technical Guide to Petroleum Economics	Tippee, B.