NATIONAL BOARD FOR TECHNICAL EDUCATION

CURRICULUM AND COURSE SPECIFICATION
FOR
NATIONAL DIPLOMA IN MINERALS AND PETROLEUM RESOURCES ENGINEERING TECHNOLOGY

DEVELOPED IN COLLABORATION WITH CENTRE OF EXCELLENCE FOR SOLID MINERALS DEVELOPMENT, WORLD BANK STEP-B PROJECT, KADUNA POLYTECHNIC

FEBRUARY, 2013

General Information for ND Mineral and Petroleum Resources Engineering Technology

NATIONAL BOARD FOR TECHNICAL EDUCATION, PLOT 'B' BIDA ROAD, PM.B. 2239, KADUNA – NIGERIA

1.0 PHILOSOPHY OF THE MINERALS AND PETROLEUM ENGINEERING TECHNOLOGY PROGRAMME

The National Diploma in Mineral and Petroleum Engineering Technology Programme is designed to reflect a FUNCTIONAL philosophy of education. While seeking to achieve academic excellence and promote the furtherance of knowledge, the Minerals Resources engineering programme also seeks to aid the acquisition of appropriate skills, abilities and competence, both mental and physical as equipment for the individual to live in and contribute to the development of his society.."

The programme is therefore committed to the production of qualified and competent technicians who will be able to face the challenges concomitant with the aspiration of the country to be technological developed and the Technicians to be self-reliant after graduation

2.0 GOALS AND OBJECTIVES OF THE PROGRAMME

The programme aims at producing mineral and petroleum resources engineering technicians for the nation's industries and public utilities and services.

On completion of the Programme, the diplomate should be able to:

a) Participate in exploration, prospecting, structural evaluation and extractive activities

b) Collate and present data in a meaningful way

c) Operate and maintain simple equipment commonly used in minerals and petroleum industries

3.0 MINIMUM ENTRY REQUIREMENTS

Candidates for admission into the programme should have a minimum of:

(i) Senior Secondary School Certificate (**SSSC**) with credit level passes in five subjects at most two sittings which must include English Language, mathematics, physics, chemistry, and one other subject from

- Biology
- Agricultural science
- Additional mathematics
- Economics
- Statistics
- Technical drawing,
- Auto-mechanics
- Geography
- Basic electronics/Basic electricity and
- Metal work

(ii) GCE ´O' Level or its equivalent (Teachers Grade II or West African School Certificate) with credit level passes in five relevant subjects as specified in (i) above.

(iii) National Technical Certificate (**NTC**) with credit passes in mathematics, chemistry, physics, English Language and one other from mechanical, electrical, radio and TV, computer and related trade areas.
(iv) Passed at NBTE recognized Pre-National Diploma courses in the relevant subjects listed in (i) above.
(v) In addition to any one of the above, Unified Tertiary Matriculation Examination (UTME) result have the required cut-off mark and subject combination of English Language, Mathematics, Physics and Chemistry.

4.0 DURATION

The duration of the programme is two academic sessions consisting of four semesters of 17 weeks each.

5.0 CURRICULUM

5.1 The curriculum of ND programme consists of five main components. These are:

i. General studies/education
ii. Foundation courses
iii. Professional courses
iv. Supervised Industrial Work Experience Scheme (SIWES)
v. Field Trip

5.2 The General Education component shall include courses in:

i. Art and Humanities - English Language, Communication, History.
ii. Social Studies - Citizenship Education, Political Science, Sociology, Philosophy, Geography and Entrepreneurship, are compulsory.
iii. Physical and Health Education (where applicable) - One semester credit only.
iv. The General Education component shall account for not more than 15% of the total contact hours for the programme.
v. Foundation courses include courses in Economics, Mathematics, Pure Sciences, Technical Drawing, Descriptive Geometry, Statistics, etc. The number of hours for the Programme may account for about 10-15% of the total contact hours.
vi. Professional courses are core courses of the programme which give the student the theory and professional skills he needs to practice his field of calling at the technician/technologist level. These may account for between 60-70% of the contact hours.
vii. Student Industrial Work Experience Scheme (SIWES) shall be taken during the long vacation following the end of the second semester of the first year. See details of SIWES at section 11.0
viii. Personal Logbook: The students to maintain a personal Logbook to record all the daily and weekly summary of all the practical activities for all the semesters.

6.0 CURRICULUM STRUCTURE

The structure of the National Diploma programme consists of four semesters of classroom, laboratory, workshop activities and field trip, and 4 months of student Industrial Work Experience Scheme (SIWES). Each semester shall be of 17 weeks duration made up as follows:

a. 15 contact weeks of teaching, i.e. recitation, practical exercise, quizzes, test, etc, and

b. 2 weeks for examinations and registration.

SIWES shall take place at the end of the second semester of the first year.

7.0 ACCREDITATION

The National Diploma programme shall be accredited by the National Board for Technical Education before the diplomates can be awarded the National Diploma certificates. Details about the process of accrediting a programme for the award of the National Diploma are available from the office of the Executive Secretary, National Board for Technical Education, Plot "B", Bida Road, P.M.B. 2239, Kaduna, Nigeria.

8.0 AWARD OF NATIONAL DIPLOMA

Conditions for the award of National Diploma include the following:

a. The satisfactory performance in all prescribed course work which may include class work, tests, quizzes, workshop practice and laboratory work should amount to a minimum of between 80 semester credit units.
b. Supervised industrial work experience for four months.
c. Satisfactory performance at all semester examinations.
d. Satisfactory completion of final year ND project work.

National Diploma should be awarded in four classes:

(i) Distinction - CGPA of 3.50 and above
(ii) Upper Credit - CGPA of 3.0 - 3.49
(iii) Lower Credit - CGPA of 2.50 - 2.99
(iv) Pass - CGPA of 2.00 - 2.49.

9.0 GUIDANCE NOTES FOR TEACHERS

9.1 The new curriculum is drawn in unit courses. This is in keeping with the provisions of the National Policy on Education which stress the need to introduce the semester credit units which will enable a student who so wishes to transfer the units already completed in an institution to another one of similar standard from which he/she is transferring.

9.2 In designing the units, the principle of the modular system by product has been adopted, thus making each of the professional modules, when completed provides the student with technician operative skills, which can be used for employment purposes (self and otherwise).

9.3 As the success of the credit unit system depends on the articulation of programmes between the institutions and industry, the curriculum content has been written in behavioral objectives, so that it is clear to all the expected performance of the student who successfully completed some of the courses or the diplomates of the programme. This is a slight departure in the presentation of the performance based curriculum which requires the conditions under which the performance are expected to be carried out and the criteria for the acceptable levels of performance. It is a deliberate attempt to further involve the staff of the department teaching the programme to write their own curriculum stating the conditions existing in their institution under which performance can take place and to follow that with the criteria for determining an acceptance level of performance. Departmental submission on the final curriculum may be vetted by the Academic Board of the institution. Our aim is to continue to see to it that a solid internal evaluation system exists in each institution for ensuring minimum

standard and quality of education in the programmes offered throughout the Polytechnic system.

9.4 The teaching of the theory and practical work should, as much as possible, be integrated. Practical exercises, especially those in professional courses and laboratory work should not be taught in isolation from the theory. For each course, there should be a balance of theory to practical in the ratio of 50:50 or 60:40 or the reverse.

10.0 LOGBOOK

A personal Log-book to be kept by the students shall contain all the day-to-day, weekly summary, and semester summary of all the practical activities from day one to the end of the programme. This is to be checked and endorsed by the lecturers concerned at the end of every week.

11.0 GUIDELINES ON SIWES PROGRAMMES

For the smooth operation of the SIWES, the following guidelines shall apply:

11.1 *Responsibility for placement of students.*

a. Institutions offering the National Diploma programme shall arrange to place the students in the relevant industry. By April 30 of each year, six copies of the master-list showing where each student has been placed shall be submitted to the office of the Executive Secretary, National Board for Technical Education, which shall, in turn, authenticate the list and forward it to the Industrial Training Fund, Jos.

b. The placement officer should discuss and agree with industry on the following:

(i) A task inventory of what the students should be expected to experience during the period of attachment. It may be wise to adopt the one already approved for each field.

(ii) The industry-based supervisor of the students during the period should note that the final grading of the students during the period of attachment should be weighted more on the evaluation by him or her.

11.2 *Evaluation of students during SIWES*. In the evaluation of the student, cognizance should be taken of the following items:

1. Punctuality;
2. Attendance;
3. General Attitude to work;
4. Respect for Authority;
5. Interest in the field/technical area;
6. Technical competence as a potential technician in his field.

11.3 *Grading of SIWES:* To ensure uniformity of grading scales, the institution should ensure that the uniform grading of students' work which has been agreed to by all polytechnics is adopted.

11.4 *The Institution-Based Supervisor: He or she* should initial the log-book during each visit. This will enable him to check whether minimum standard/requirement are being met and to assist students having any problems regarding the specific assignments given to them by their industry-based supervisor.

11.5 *Frequency of Visit*: Institution should ensure that students placed on attachment are visited within one month of their placement. Other visits shall be arranged so that:

1. there is another visit weeks after the first visit; and
2. a final visit in the last month of the attachment.

11.6 *Stipend for Students in SIWES*: The rate of stipend payable shall be determined from time-to-time by the Federal Government after due consultation with the Federal Ministry of Education, the Industrial Training Fund and the National Board for Technical Education.

11.7 *SIWES as a component of the curriculum*: The completion of SIWES is important in the final determination of whether the student is successful in the programme or not. Failure in the SIWES is an indication that the student has not shown sufficient interest in the field or has no potential to become a skilled technician in his field. Where a student has satisfied all other requirements but failed SIWES, he may only be allowed to repeat another four months' SIWES at his own expense.

12.0 FINAL YEAR PROJECT

Final year students in this programme are expected to carry out a project work. This could be on individual basis or group work, but reporting should be on individual basis. The project should, as much as possible incorporate basic elements of design, drawing and complete fabrication of a marketable item or something that can be put to use. Project reports should be well presented and should be properly supervised.
The departments should make their own arrangement of schedules for project work.

Guidelines for text book writers

NATIONAL DIPLOMA AND HIGHER NATIONAL DIPLOMA

The following guidelines are suggestions from the Engineering Committees to the writers of the textbooks for the new curricula. They are intended to supplement the detailed syllabuses which have been produced, and which define the content and level of the courses.
Authors should bear in minds that the curriculum has been designed to give the students a broad understanding of applications in industry and commerce, and this is reflected in the curriculum objectives.

- One book should be produced for each syllabus
- Page size should be A4
- The front size should be 12 point for normal text and 14 point where emphasis is need
- Line spacing should be set to 1.5 lines
- Headings and subheadings should be emboldened
- Photographs, diagrams and charts should used extensively thought the book, and these items must be up-to-date
- In all cases the material must be related to industry and commerce, using real life examples wherever possible so that the book is just a theory book. It must help the students to see the subject in the content of the 'real word"
- The philosophy of the courses is one of an integrated approach to theory and practice, and as such the books should reflect this by not making an artificial divide between theory and practice.
- Illustrations should be labeled and numbered.
- Examples should be drawn from Nigeria wherever possible, so that the information is set in a country context.
- Each chapter should end with student self-assessment quotations (SAQ) so that student can check their own master of the subject.
- Accurate instructions should be given for any practical work having first conducted the practical to check that the instructions do indeed work
- The books must have a proper index or table of contents, a list of references and an introduction based on the overall course philosophy and aims of the syllabus.
- Symbols and units must be listed and a unified approach used throughout the book
- In case of queries regarding the contents of the books and the depth of information, the author must contact the relevant curriculum committee via the National Board for technical Education.
- The final draft version of the books should be submitted to Nigerian members of the curriculum working groups for their comments regarding the content in relation to the desired syllabus.

Course outline

1. **General studies and management courses**
   Use of English
   Communication in English
   Citizenship education
   Practice of entrepreneurship
   Technical report writing
   Entrepreneurship development
   Economics

2. **Mathematical courses**
   Logic and linear algebra
   Algebra and elementary trigonometry
   Calculus
   Trigonometric and analytical geometry
   Statistics
3. **Civil Engineering**
   Soil Mechanics
4. **Computer and information technology**
   Computer systems and programming
5. **Electrical engineering courses**
   Electrical engineering science
6. **Mechanical engineering courses**
   Technical drawing
   Descriptive geometry
   Engineering thermodynamics
   Fluid mechanics
   Strength of materials
   Engineering mechanics
   Basic workshop practice
7. **Minerals and petroleum engineering courses**
   Introduction to mineral processing Technology
   Materials science
   Introduction to geology
   Safety and environmental control
   Introduction to mining Technology
   Stratigraphy
   Introduction to Petroleum Technology
   Mineralogy and petrology
   Mineral exploration and evaluation
   Mineral processing and extractive metallurgy
   Structural and field geology
   Petroleum drilling technology
   Petroleum production technology
   Basic surveying
   Mining methods

CURRICULUM TABLES
NATIONAL DIPLOMA IN MINERALS AND PETROLEUM RESOURCES ENGINEERING TECHNOLOGY

First Semester

Course Code	Course Title	L	T	P	CU	CH	Prerequisite
GNS 101	Use of English (Grammar)	2	-	-	2	2	
GNS 111	Citizenship Education	2	-	-	2	2	
MTH 112	Algebra and Elementary Trigonometry	2	1	-	3	3	
MEC 101	Technical Drawing	1	-	2	3	3	
MEC 111	Engineering Mechanics	2	-	2	4	4	
EEC 112	Electrical Engineering Science	2	-	2	4	4	
MPE 101	Introduction to Mineral Processing Technology	1	-	2	3	3	
MPE 103	Introduction to Geology	1	-	2	3	3	
MPE 105	Introduction to Mining Technology	1	-	2	3	3	
MPE 107	Introduction to Petroleum Technology	1	-	2	3	3	
Total		14	1	16	30	30	

Second Semester

Course Code	Course Title	L	T	P	CU	CH	Prerequisite
GNS 102	Communication in English	2	-	-	2	2	
GNS 201	Economics	2	-	-	2	2	
EED 126	Introduction to Entrepreneurship Education	1	-	2	3	3	
MTH 211	Calculus	2	-	-	2	2	
STA 111	Statistics	2	-	-	2	2	
MEC 102	Descriptive Geometry	1	-	2	3	3	
MEC 122	Engineering Thermodynamics	1	-	3	4	4	
MEC 105	Basic Workshop Practice	-	-	3	3	3	
MPE 102	Material Science	2	1	-	3	3	
MPE 104	Safety and Environmental Control	2	-	-	2	2	
MPE 106	Stratigraphy	1	-	2	3	3	
Total		16	1	12	29	29	

Third Semester

Course Code	Course Title	L	T	P	CU	CH	Prerequisite
GNS 201	Technical Report writing	2	-	-	2	2	
EED 216	Practice of Entrepreneurship	1	-	2	3	3	
MTH 111	Logic and Linear Algebra	2	-	-	2	2	
MEC 207	Fluid Mechanics	1	-	2	3	3	
MPE 201	Mineralogy and Petrology	2	-	3	5	5	MPE 103
MPE 203	Mineral Processing & Extractive Metallurgy	2	-	3	5	5	MPE 101
MPE 205	Petroleum Drilling Technology	2	-	3	5	5	MPE 107
MPE 207	Basic Surveying	1	-	3	4	4	
MPE 209	Mining Methods	3	-	-	3	3	MPE 105
Total		15	-	16	32	32	

Fourth Semester

Course Code	Course Title	L	T	P	CU	CH	Prerequisite
MTH 122	Trigonometric and Analytical Geometry	2	1	-	3	3	
MEC 222	Strength of Materials	2	-	2	4	4	
CEC 210	Soil Mechanics	1	-	3	4	4	
MPE 202	Prospecting and Exploration of Deposits	1	-	3	4	4	MPE 201
MPE 204	Structural and Field Geology	1	-	3	4	4	Ditto
MPE 206	Petroleum Production Technology	2	-	3	5	5	MPE 205
EEC 241	Computer Systems and Programming	1	-	3	4	4	
MPE 212	Final Year Project	-	-	5	5	5	
Total		10	1	22	33	33	

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

	Department/Programme: ND Minerals and Petroleum Resources Engineering	**Course Code: MPE 101**		**Contact Hours: 3**
	Subject/Course: Introduction to Mineral Processing Technology			**Theoretical:1 hours/week**
	Year: ND 1 Semester: 1st	**Pre-requisite:**	**-**	**Practical:2 hours/week**

General Objectives

1.0 Know the relationship between mineral processing and other allied courses

2.0 Know the mineral processing units operations

3.0 Understand ore sampling and assaying

4.0 Understand Communition and its stages

5.0 Know the Principles and methods of sizing

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

	Course: Introduction to Mineral Processing Technology	**CODE: MPE 101**			**CONTACT HOURS: 3 HRS/WK**	
					Theoretical: 1 hours/week	
	Year: 1st Semester: 1st	**Pre-requisite:**			**Practical: 2 hours/week**	
	THEORITICAL CONTENT			**PRACTICAL CONTENT**		
Week	**General Objective: 1.0 Know the relationship between Mineral Processing and other allied courses**					
	Specific Learning Outcome	**Teachers Activities**	**Resources**	**Specific Learning Outcome**	**Teachers Activities**	**Resources**
1 2	1.1 Define minerals, ore and rocks. 1.2 Define Mineral processing 1.3 Relate mineral processing to mining, geology, metallurgy, etc. 1.4 List major minerals (metallic and non-metallic Nigerian examples.) 1.5 State sources, characteristics, market requirements, current selling prices, uses and major buyers of minerals in 1.3 above.	1. Develop instructional manual for teaching this course. 2. Distinguish between minerals, ore and rocks 3. Describe the various specializations and stages of the mineral exploitation industry 4. Identify major minerals in Nigeria and their locations. 5. Evaluate the students on the major stakeholders in mineral market.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.			
	General Objective: 2.0 Know the mineral processing units operations					
	2.1 Explain the unit operations in mineral processing. 2.2 Identify the major unit operations. 2.3 Identify the auxiliary unit operations	• List the unit operations • Distinguish the functions of the unit operations • Evaluate the students	Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.	• Appreciate mineral processing equipment in the laboratory.	Draw equipment found in mineral processing laboratory	Practical Manual. Drawing paper, pencils, ink, eraser, drawing board.
week	**General Objective 3.0: Understand sampling and assaying**					
3 4	3.1 Explain methods of sampling 3.2 Describe sampling equipment 3.3 State the importance of sampling and sampling preparation 3.4 Describe assaying 3.5 Enumerate assaying types 3.6 State the importance of assaying -	1. Distinguish between hand and mechanical sorting. 2. Explain sampling assaying. 3. Ask the students to understand ore and product handling processes. 4. Evaluate the students	Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.	• Demonstrate the methods of sampling • Demonstrate simple assaying	• Develop practical manual for laboratory/workshop exercises in this course. • Provide sample(s)	Practical Manual. Splitter, quartering equipment, Lab report book, basic reagents assaying, facilities
	General Objective 4.0: Understand Communition					
	4.1 Explain the theory and principle underlying Communition 4.2 State methods of Communition crushing and grinding. 4.3 Define crushing 4.4 Explain Primary and Secondary	• State the and principle underlying Communition • Describe crushing and grinding • Differentiate between crushing and grinding • Evaluate the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.	• Perform crushing and grinding	• Prepare practical as indicated in the manual • Provide sample(s)	Practical Manual. Crusher, Pulveriser and grinding mill(s)

	Crushing 4.5 Lists crushing equipment 4.6 Define grinding 4.7 Enumerate grinding equipment 4.8 Distinguish between crushing and grinding processes					
	General Objective: 5.0 Know the principles and methods of sizing					
5-6	5.1 State types of sizing appliances, i.e. sieves, screens etc 5.2 Identify the appliances in 3.1 5.3 Explain the purpose of sizing 5.4 Enumerate types of screen surfaces 5.5 Explain screening efficiency 5.6 Enumerate factors affecting sizing operation 5.7 Give graphical illustration of sizing 5.8 Describe the action of particles on the screens 5.9 Distinguish between wet and dry screening 5.10 Describe sizing devices such as cyclones, thickeners, filters, setting cones, trommels, etc.	1. State, identify and explain types of sizing appliances. 2. List factors controlling sizing operation 3. Describe sieve analysis data generation and presentation in graphs and tables 4. Evaluate the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.	• Use the appliances in 3.1 and devices in *3.10* to perform sizing operation • Carry out sieve analysis and prepare reports	• Prepare practical as indicated in the manual • Provide sample(s)	Practical Manual. Crusher, Pulveriser, grinding mill(s), sieves and sieve shaker
	ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 40% of the total score. The end of the Semester Examination will make up for the remaining 60% of the total score.					

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

	Department/Programme: ND Minerals and Petroleum Resources Engineering	**Course Code: MPE 103**		**Contact Hours:3/week**
	Subject/Course: Introduction to Geology			**Theoretical: 1 hours/week**
	Year: ND 1 Semester:1st	**Pre-requisite:**	**-**	**Practical: 2 hours/week**

General Objectives

1.0: Know the origin, structure and composition of the earth

2.0: Understand the surface processes of the earth

3.0: Understand the internal processes of the earth

4.0: Appreciate geological engineering as a subject and its application

5.0: Know geology and the mineral occurrences in Nigeria

6.0: Understand petroleum source rock

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

	Course: Introduction to Geology		**CODE: MPE 103**		**CONTACT HOURS: 3 HRS/WK**	
					Theoretical: 1 hr/wk	
	Year: ND 1 Semester:1st		**Pre-requisite:**		**Practical:2 hrs/wk**	
	THEORITICAL CONTENT			**PRACTICAL CONTENT**		
Week	**General Objectives 1.0: Know the origin, structure and composition of the earth**					
	Specific Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
1-4	1.1 Explain the formation *of* the earth 1.2 Give the various theories *of* the Earth's formation 1.3 Relate the origin *of* the earth to evolution of other planets. 1.4 Identify the internal zones *of* earth (crust, mantle and core) 1.5 Describe the physical characteristics *of* the zones in 1.4 1.6 List the major elements found in the different zones in 1.4 and their relative abundance.	• Develop instructional manual for teaching this course. • Explain the origin, structure and composition of the earth • Identify and describe physical characteristics of the internal zones of the earth. • List the major elements found in the different zones	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.	1. Draw and label the internal structure of the earth 2. Indicate the composition of each of the three major zones of the internal structure	• Develop practical manual for laboratory/workshop exercises in this course. • Prepare practical as indicated in the manual	Practical Manual. Drawing paper, pencils, ink, eraser, drawing board, reference chart of the earth's structure
	General Objective 2.0 Understand the surface processes of the earth					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
5-9	2.1 Define weathering 2.2 Lists the types of weathering 2.3 Describe the mechanism *of* the processes in 2.1 2.4 Enumerate the importance of weathering 2.5 Describe hydrologic cycle 2.6 Define erosion 2.7 Describe the effect of erosion on terrains 2.8 nes and related forms).	1. Explain physical and chemical weathering 2. List the surface and internal processes of the earth. 3. Explain the activities in 2.3 to 2.10 4. Enumerate the adverse effect and by-product of erosion, earthquake and volcanic eruptions 5. Evaluate the students.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.	Field trip to see weathered rock in-situ and erosion sites	• Develop practical manual for laboratory/workshop exercises in this course. • Prepare practical as indicated in the manual	Safety helmets, safety boots, first aid facilities, field vehicle, GPS, geological hammer, sample bags, topographic map
	General Objective 3.0 Understand the internal processes of the earth					
	Specific Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
	3.1 Define earth quakes. 3.2 Explain the genesis of earth quake 3.3 Explain the method *of* measuring earthquakes 3.4 Enumerate the effects of earth quake 3.5 Define Volcano 3.6 Describe the nature *of* volcanic products (e.g. volcanic gases, lava flows, volcanic cones, etc.)	• Explain the mechanisms involved in earth quake phenomena. • Explain volcanic activities. • Explain the after effect of volcanic eruptions on the ecosystem.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.	Field trip to see volcanic products e.g. vesicular basalt, pumice, volcanic ash, etc.	• Develop practical manual for laboratory/workshop exercises in this course. • Prepare practical as indicated in the manual	Practical Manual. Safety helmets, safety boots, first aid facilities, field vehicle, GPS, geological hammer, sample bags, topographic map
	General Objective 4.0: Appreciate geological engineering as a subject and its application					

	Specific Learning Outcome:	Teachers Activities	Resources	Specific Learning Outcome:	Teachers Activities	Resources
	4.1 Define geological engineering 4.2 List the various applications of geological engineering 4.3 Relate geological engineering to other disciplines	Describe geological engineering and its various applications	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.			
	General Objective 5.0: Know geology and the mineral occurrences in Nigeria					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
10-14	5.1 Explain with maps the distribution of major rock types. 5.2 Explain the major sedimentary basins and their successions. 5.3 Enumerate Nigeria's mineral resources. 5.4 Describe the occurrences and distribution of the mineral in 3.3 above. 5.5 Describe with maps, the Niger delta petroleum province. 5.6 Give the history of oil exploration and exploitation. 5.7 Undertake excursion to mineral deposit locations in Nigeria.	1. Explain the geology and the mineral occurrences of Nigeria 2. Give details of mineral resources distribution/locations in Nigeria using mineral map 3. Present with the aid of a map Niger Delta petroleum province 4. Evaluate the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.	1. Draw geological maps of Nigeria to show the basement complex, sedimentary basins, meta-sediments and younger granites 2. Draw the minerals map of Nigeria	• Develop practical manual for laboratory/workshop exercises in this course. • Prepare practical as indicated in the manual	Practical Manual. Drawing paper, pencils, ink, eraser, drawing board
	General Objective: 6.0: Understand petroleum source rock					
	6.1 List source rock and its characteristics 6.2 Explain the process of generation of hydrocarbon 6.3 Describe oil migration 6.4 Explain reservoir rock 6.5 List characteristics of reservoir rock 6.6 Explain briefly the concept of well logging.	1. Explain the term source rock 2. Describe the requirements for hydrocarbon generation 3. List factors responsible for oil migration 4. Explain types of traps 5. List types of logs	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.			
ASSESSMENT: The continuous assessment, tests, practical works and quizzes will be awarded 40% of the total score. The end of the Semester Examination will make up for the remaining 60% of the total score.						

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

	Department/Programme: Minerals Resources Engineering/ND	**Course Code: MPE 105**		**Contact Hours: 3**
	Subject/Course: Introduction to Mining Technology			**Theoretical: 1 hours/week**
	Year: ND 1 Semester:1st	**Pre-requisite:**	**-**	**Practical: 2 hours/week**

General Objectives

1. Understand technical terminology used in mining
2. Understand elementary principles of prospecting and exploration
3. Understand factors involved in exploitation *of* mineral deposits
4. Know the types of mining methods
5. Know basic principles *of* rock drilling in mining operations
6. Know rock drilling equipment and their application
7. Know the types of mining explosives and their accessories
8. Know methods *of* priming explosive cartridges
9. Understand the mining laws and regulations vis-a-vis handling explosives

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

	Course: Introduction to Mining Technology	**Course Code: MPE 105**		**Contact Hours: 3**	
				Theoretical:1 hours/week	
	Year: ND 1 Semester: 1st	**Pre-requisite:**	**-**	**Practical:2 hours/week**	
	Theoretical Content		**Practical Content**		
	General Objective 1.0: Know technical terminology used in mining				
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
1	1.1 Define geological terminologies, such as ore, lode, ore-shoot, vein, Bedded deposits, massive deposits, placer, deposits, folds, faults, etc. 1.2 Define the following mining terminologies; mining, prospecting, exploration, development, exploitation prospecting lease, mining lease, hanging-and footwall, shaft, drift, level drift, winze, tunnel, stope back, adit, cross cut.	1. Develop instructional manual for teaching this course. 2. Explain geological and mining terminologies, 3. Sketch cross-sections and longitudinal sections of ore deposits and label them. 4. Illustrate diagrammatically a 3D view of a typical mine showing all the features therein	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.	Sketch cross-sections and longitudinal sections of ore deposits and label the relevant terms in 1.2 above	• Develop practical manual for laboratory/workshop exercises in this course. • Prepare practical as indicated in the manual	Practical Guide/Manual. Drawing paper, pencils, ink, eraser, drawing board
	General Objective 2.0: Know the elementary principles of prospecting and exploration					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
2	2.1 Explain, (a) types of prospecting (b) methods of prospecting (c) types of sampling (d) methods of sampling	1. Describe prospecting and exploration methods 2. Identify the prospecting and exploration equipment	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.	• Using electronic media, appreciate the pre-mining, development and reclamation stages of mineral exploitation. • Submit report on experiences above.	Anchor the film/slide presentation of the development/exploitation stages in mine development	Practical Manual. Overhead Projector, Computer/Laptop System, Slide, Internet/YouTube, CD/DVD Documentaries.
	General Objective: 3.0 Know the factors involved in exploitation of mineral deposits					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
3-4	1.1 Explain the factors influencing the methods of development; (a) size (b) shape (c) dip and strike (d) grade of deposits determined by drilling (e) faults and folds (f) Water bearing strata, etc. . 1.2 Explain environmental and economic factors, e.g. (a) location of the deposit (b) infrastructural facilities (c) Politics (f) economics.	1. Enumerate the factors involved in exploitation of mineral deposits 2. Discuss in details; technical, economic and other factors to be considered in the exploitation of mineral deposit. 3. Evaluate the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint, Projector, Screen, Magnetic Board, etc.			

	General Objective:4.0 Know the types of mining methods					
	Specific Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
5	4.1 Classify mining methods in the following general terms (a) Surface mining (b) Underground mining (c) Open-cut (d) Opencast mining (e) Placer-mining 4.2 Explain each method in 4.1 above 4.3 State the mining methods applicable to: (a) Coal deposits in Enugu and Okaba (b) Tin deposits in Jos and Cornwall U.K. (c) Iron deposits in Itakpe and Kiruna Sweden (d) Pb/Zn in Obi and Alkaleri 4.4 Differentiate between placer mining and other forms of surface mining. 4.5 Differentiate between underground methods of mining metalliferrous and non-metalliferous deposits 4.6 List advantages and disadvantages of surface and underground workings in the following respects. (a) environmental (b) economic (c) safety, etc.	1. Classify and explain mining methods 2. Give an overview of all mining methods with emphasis to their selection in terms of technical as well as economic consideration, to be considered in applying a particular in favour of another, with examples from Nigerian mining industry 3. Evaluate the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.	Carryout field trip/excursion to quarries, mines, prospecting/exploration outfits etc.	Anchor field excursions.	Practical Manual. Journals. e-media, Internet etc.
	General Objective: 5.0 Know basic Rock drilling principles in mining operations					
	Specific Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
6	5.1 Define drilling 5.2 Describe the mechanics of rock fragmentation 5.3 Explain the need for the removal of rock chippings by: (a) air flushing (b) water flushing.	1. Describe rock drilling principles in mining Evaluate the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.			
	General Objective 6.0: Know Rock drilling equipment and their application					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
7-8	6.1 Classify rock drilling equipment according to working principles (a) percussive	1. List and explain rock drilling equipment and their application	Instructional Manual. Recommended	Carry out practical on drilling operations.	• Explain safety precautions in drilling. • Guide on the conduct of	Variety of rock drilling machines.

	(b) rotary (c) rotary-percussive drilling. 6.2 List different types of rock drilling equipment in use (a) open cast work, (b) underground coal mining, and (c) underground metalliferous mining. 6.3 State essential features of equipment listed in 6.2 6.4 List and describe various types of drill-bits, ego chisel, cross and x-bits, button, retro and retrac, drag, rolling cutter, and cone bits. 6.5 Demonstrate the use of drill-bits in 6.4 in rock drilling.	2. Explain different types of drilling and where they are applied 3. Illustrate diagrammatically drilling equipment and 4. Evaluate the students	textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.		practicals.	
	General Objective 7.0: Know the types of mining explosives and their accessories					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
9-10	7.1 Explain the following properties of explosives; detonation velocity, detonation pressure, energy, strength, water resistance, sensitivity fume characteristics, flammability. 7.2 Tabulate principal types of explosives in relation to their essential ingredients and application. (a) straight dynamite (b) ammonia dynamite (c) straight gelatin (d) ammonia gelatin (e) blasting gelatin (f) granulated dynamite (g) permissible explosive for coal mines h) explosives not containing nitroglycerine (i) Ammonium nitrate, nitro starch and chlorate classes. 7.3 List and describe blasting accessories such as safety fuse, igniter *cord,* detonating cord, electric detonators, plain detonators, delay and relay. 7.4 Identify the accessories in 7.3 above 7.5 State the uses of accessories in 7.3	• Explain the types of mining explosives and their accessories • Enumerate properties of explosives in tabular presentation • List types of explosives and their composition • Enumerate blasting accessories and their functions • Evaluate the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.			
	General Objective 8.0 Know Methods of priming explosive cartridges					

Week	Specific Learning Outcome:	Teachers Activities	Resources	Specific Learning Outcome:	Teachers Activities	Resources
11-12	8.1 Define the term priming 8.2 Explain safe method of priming with cap and fuse. 8.3 Explain with sketches, cap and fuse assembly 8.4 Identify the tools required for priming; (pricks, crimper). 8.5 Explain with sketches, the methods for priming explosive cartridge. 8.6 Demonstrate the methods with dummy caps and cartridges. 8.7 Explain recommended methods of firing explosives.	1. Define and explain methods of priming explosive cartridges 2. Demonstrate activities as in 8.2 to 8.4 3. Carry out as in 8.5 4. Asses the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.			
	General Objective 9.0 :Understand mining laws and regulations as regard to handling of explosives					
	Specific Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
13-14	9.1 Explain the mining laws regarding explosives handling, transportation and storage 9.2 State procedures of explosive transportation to the mine. 9.3 Explain the construction and features of explosive carriers. 9.4 Describe explosive handling care within the mine and quarry. 9.5 Explain the methods of disposal of damaged explosives and blasting caps.	1. Cite relevant areas of Nigerian Mining and Minerals Act and regulations concerning explosives handling 2. Explain safety approaches to handling, care and application of explosives in mines and quarries 3. Assess the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.			
	ASSESSMENT: The continuous assessments, tests and quizzes will be awarded 40%, while the remaining 60% will be for the end of the Semester Examination Score.					

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

	Department/Programme: ND Minerals and Petroleum Resources Engineering	**Course Code: MPE 107**		**Contact Hours:**
	Subject/Course: Introduction to Petroleum Technology			**Theoretical: hours/week**
	Year: Semester:	**Pre-requisite:**		**Practical: hours/week**

General Objectives

1. Understand the occurrence of the reservoir rock
2. Understand reservoir pore space
3. Understand elements of reservoir engineering
4. Understand well testing

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

PROGRAMME: NATIONAL DIPLOMA MINERAL RESOURCES ENGINEERING						
Course: Introduction to Petroleum Technology		**Course Code: MPE 107**		**Contact Hours 5HRS/WEEK**		
Course Specification: Theory, Practical and Field Trip						
Week	**General Objective 1.0: Understand the occurrence or the reservoir rock**					
	Specific Learning Outcome:	**Teacher Activities**	**Resources**	**Specific Learning Outcome:**	**Teacher Activities**	**Resources**
1-5	3.1 Explain how geological age of the reservoir rocks can be determined. 3.2 Describe subsurface occurrence: shower, pools, fields and province. 3.3 Explain the significance of reservoir pore space in petroleum exploitation.	1. Develop instructional manual for teaching this course. 2. Distinguish between showings, pools, field and province 3. Explain the origin of pore space in reservoir.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 2.0: Understand reservoir pore space					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
6-8	2.1 Define porosity, permeability and their measurement 2.2 Distinguish between effective and relative permeability. 2.3 Explain the relationship between porosity and permeability.	• Explain how to distinguish between porosity and permeability and relationship. • Assess the students	Instructional Manual.	3.1 Conduct practical on porosity and permeability 3.2 Determination fluid saturation	▪ Carried out practical on how to determine porosity and permeability of different samples. ▪ Carried out practical to determine fluid saturation of different samples.	Practical Manual. Computer related software, projectors, laboratory equipment, and practical manuals recommended apparatus.
	General Objective 3.0: Understand elements of reservoir engineering					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teacher Activities**	**Resources**
9-11	4.1 Describe types of reservoir. 4.2 Explain the physical characteristics of reservoir rocks. 4.3 Explain the properties of reservoir, rocks, and fluids numerical applications on porosity, permeability and fluid saturation.	▪ Explain different types of reservoirs. ▪ Enumerate properties of reservoir rocks and fluid. ▪ Assess the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 4.0: Understand well testing					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teacher Activities**	**Resources**
12-15	5.1 Explain well testing programmes e.g. Drill stem (DST), Production Test for non-eruptive well, gas lifted well etc. 5.2 Describe Oil and Gas testing	▪ Give student assignment on well testing simulation ▪ Assess the student	Instructional Manual. Field Trip E-Media Computer System. Overhead Projectors	Carryout field trip/view film to appreciate: 1. Anatomy of a rig 2. Components of rig and their functions 3. Observe rig operations	Anchor field trips	Practical Manual. Computer Simulation, computer system, recommended apparatus, parts.
ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 40% of the total score. The end of the Semester Examination will make up for the remaining 60% of the total score.						

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

	Department/Programme: ND Minerals and Petroleum Resources Engineering	**Course Code: MPE 102**		**Contact Hours: 3**
	Subject/Course: Materials Science			**Theoretical: 1 hours/week**
	Year: 1st Semester:2nd	**Pre-requisite:**	**-**	**Practical: 2 hours/week**

General Objectives:

1. Understand materials and their properties

2. Know the structure of an atom

3. Understand atomic bonding and coordination

4. Know crystalline phases.

5. Understand phase equilibria and solid solution.

6. Know the construction and interpretation of phase diagram.

7. Know alloying elements and properties

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

	Course: Materials Science			**Course Code: MPE 102**		**Contact Hours: 3**
						Theoretical: 2 hr/wk
	Year: ND I Semester: 2nd			**Pre-requisite:**		**Tutorial: 1 hrs/wk**
	Theoretical Content			**Practical Content**		
Week	**General Objective 1.0: Understand materials and properties**					
	Specific Learning Outcome:	**Teacher Activities**	**Resources**	**Specific Learning Outcome:**	**Teacher Activities**	**Resources**
1-4	1.1 State types of engineering materials. 1.2 Define mechanical properties of materials: stress, strain, elastic modulus, yield strength, tensile strength, ductility, and elongation, reduction of area, hardness and toughness. 1.3 Define thermal expansion, heat capacity and thermal conductivity of material 1.4 Define electrical conductivity, resistivity and polarisation of engineering materials. 1.5 State the relationship between electrical conductivity and temperature, strain, composition and thermal con-ductivity. 1.6 Solve mathematical problems associated with properties in 1.2, 1.3 and 1.4 above	1. Develop instructional manual for teaching this course. 2. Define materials science 3. To solve mathematical problems associated with mechanical properties 4. State the role of each property in 1.2 above in engineering applications of materials. 5. State the relevance of thermal expansion, heat capacity and thermal conductivities of materials 6. Evaluate the students.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 2.0: Know structure and of an atom.					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teacher Activities**	**Resources**
5-7	2.1 Describe electronic structure of atoms. 2.2 Give an expression of the relationship between energy possessed by a photon and its wave-length. 2.3 Explain electron notations using S,P,D sub-shell of K, L,M,N,O shells of an atom. 2.4 Explain energy distributions and electron excitation in atoms. 2.5 Solve mathematical problems associated with 2.2 and 2.4 above.	1. Define atom and explain its structure of and 2. Explain electron notations 3. Define electron excitation 4. Give examples mathematical problems 2.2 and 2.4	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 3.0: Understand atomic bonding and coordination.					
Week	**Specific Learning outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teacher Activities**	**Resources**
8-10	3.1 State the four general types of inter-atomic bonds in	1. Explain atomic bonding and coordination.	Instructional Manual.			

	materials 3.2 Explain the occurrence of inter-atomic bonds in materials. 3.3 Explain the expression showing the relationship bet-ween energy change of two approaching ions and their inter ionic distance and electron charges. 3.4 Define coordination number and ionic radius. 3.5 Relate coordination number with radii ratios and state how they affect ionic and/or covalent bonding. 3.6 Explain the terms; polyatomic ions, and free radical and state their effect on engineering materials properties.	2. Demonstrate the activities in 3.4 to 3.7 3. Evaluate the students	Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 4.0: Know crystalline phases.					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teacher Activities**	**Resources**
11-14	4.1 Define a phase, crystalline solids, short-range long-range orders, and give examples of each. 4.2 Describe the close-packed crystals (hcp, fcc) and body centered cubic (bcc) cyrstals with examples. 4.3 Describe the structure of ionic and molecular crystals and give examples. 4.4 Define polymorphism of crystals and use carbon, iron and titanium as examples.	1. Distinguish between hcp and fcc crystal systems 2. Explain the ironic and molecular crystal structure 3. Demonstrate polymorphism of crystals inhibited by carbon, iron and titanium.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective: 5.0: Phase equilibria and solid solution					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
	6.1 Describe the phase equilibria of one component system and its practical use 6.2 Describe phase equilibria of two components system 6.3 Classify alloys 6.4 Define solid solution 6.5 Describe and classify solid solution 6.6 State Hume-Rothery's theory on solid solution 6.7 Explain interstitial solid solution and their contribution	1. Explain the phase equilibria of 1 and 2 components systems. 2. Explain solid solution 3. Enumerate the type of solid solution	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip			

	to properties of steel					
	General Objective: 6.0: Know construction and interpretation of phase diagram					
	Specific Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
	6.1 Define Gibb's phase rule 6.2 Explain the partial and integral thermodynamic functions for solutions 6.3 Construct and explain phase equilibrium diagram 6.4 Write and explain Claussias-Clayperson equation 6.5 Solve problems on phase equilibrium for one component system 6.6 Explain the use of lever rule for two phase systems involving: (a) complete solubility in both liquid and solid state (b) eutectic reaction (c) partial solubility in solid state, i.e. precipitation (d) Peritectic reaction (e) Intermetallic phases	1. Explain Gibb's phase rule 2. Describe the partial and integral thermodynamic functions for solutions 3. Explain Claussias-Clayperson equation 4. Give examples of problems on phase equilibria for one component system	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip			
	General Objective: 7.0: Alloying element and properties					
	Specific Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
	7.1 Define alloy steels 7.2 Explain main effect of carbon in steel 7.3 Describe the effect of alloying elements on the equilibrium diagram base on Fe – Fe_3C. 7.4 Explain the effect of austenite and ferrite stabilizers	1. Lists and explain the types of alloy steel 2. Describe the effect of carbon in steel 3. Describe the effect of Austenite and ferrite stabilizer	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip			
	ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 40% of the total score. The end of the Semester Examination will make up for the remaining 60% of the total score.					

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

	Department/Programme: ND Minerals and Petroleum Resources Engineering	**Course Code: MPE 104**		**Contact Hours: 2**
	Subject/Course: Safety and Environmental Control in the Extractive Industry			**Theoretical: 2 hours/week**
	Year: ND I Semester: 2nd	**Pre-requisite:**	**-**	**Practical: hours/week**

General Objectives

1.0: Know the legislations relevant to health and safety

2.0: Understand the Mining and Petroleum Legislations

3.0: Know the development of an effective safety policy

4.0: Understand accident reporting and investigation

5.0: Understand environmental control in the extractive industry

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

	Course: Safety and Environmental Control in the Extractive Industry		**Course Code: MPE 104**		**Contact Hours 2HRS/WEEK**	
					Theoretical: 1 hr/wk	
	Year: ND 1 Semester:2nd		**Pre-requisite:**		**Practical:2 hrs/wk**	
	THEORITICAL CONTENT			**PRACTICAL CONTENT**		
Week	**General Objective 1.0: Know the legislations relevant to health and safety**					
	Specific Learning Outcome:	**Teacher Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
1-4	1.1 Outline the main provisions of the health and safety act at work. 1.2 Outline the main provisions of the Factories Act Fire Precautions. 1.3 State the relevance of Common Law to health and safety at work. 1.4 Explain the general duties in respect of health and safety of employers and employees others in work places, etc.	1. Develop instructional manual for teaching this course. 2. Outline the provisions of the health and safety act at work place. 3. State the relevance of common law to health and safety at work. 4. Narrate the general duties in respect of health and safety of employers and others in control of work places, employees, suppliers, etc.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.			
	General Objective 2.0: Understand the Mining and Petroleum Legislations					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
5-7	2.1 Outline the main provision of (a) Nigerian Minerals and Mining Act. (b) Petroleum Act.	1. Outline the main provisions of minerals, petroleum and quarries act. 2. Outline the main provisions of petroleum act. 3. Explain the difference between PA and the proposed PIB 4. Evaluate the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.			
	General Objective 3.0: Know the development of an effective safety policy					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
8-9	3.1 Outline the principles of developing effective safety policy 3.2 Explain the need for a. accident prevention b. Psychological basis for accident prevention. c. economic basis for accident prevention 3.3 Categorize potential causes of physical injuries and occupational illness. 3.4 Describe possible preventive measures for 3.3 above 3.5 Explain personal safety considerations, working prac-	1. Discuss the importance of an effective safety policy 2. Enumerate causes of work place accident, physical injuries and occupational illness 3. Mention personal protective apparels using mines, quarries and mills 4. Highlight the importance of safety management policy 5. Evaluate the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.			

	tice and hazards associated with the following: a. Personal protection equipment. b. Fire and explosion hazards c. Special safety measures 3.6 Explain the role of management, supervisors, safety officers and operators in safety enforcement and compliance 3.7 Enumerate sources of information and materials needed in case of emergency. 3.8 Explain rescue techniques.					
	General Objective 4.0: Understand accident reporting and investigation					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
10-11	4.1 Classify accidents. 4.2 State the procedure for reporting accidents to ap-propriate authorities. 4.3 List the main elements of oral and written reports of accidents and their purpose. 4.4 Use the reports of accidents in generating statistical data for prevention and control of accident (e.g. frequency rate).	1. Classify accidents 2. State the procedure for reporting accidents 3. List the main elements of oral and written reports of accidents and their purposes.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.			
	General Objective 5.0: Understand environmental control in the extractive industry					
12	5.1 List the main sources of pollution in the mining, petroleum and mineral processing industry. 5.2 Describe disposal methods for liquid, solid and gaseous wastes from mining, petroleum and mineral processing industries. 5.3 Outline preventive methods adopted in the mining, petroleum and mineral processing Industries to check pollution 5.4 Outline the importance of Environmental Impact Assessment 5.5 Outline the main provision of relevant legislations (e.g. NESRIA Act, Mineral Act, Petroleum Act, etc) on environmental control.	1. Explain the value of environmental control 2. Explain proper process of waste disposal system 3. Demonstrate how preventive methods in mining and minerals processing methods control pollution 4. Cite relevant areas from mining and mineral processing Act and latest mining regulations concerning effect of mining on the environment 5. Assess the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, etc.			
	ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 40% of the total score. The end of the Semester Examination will make up for the remaining 60% of the total score.					

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

	Department/Programme: ND Minerals and Petroleum Resources Engineering	**Course Code: MPE 106**		**Contact Hours: 3**
	Subject/Course: Stratigraphy			**Theoretical: 1 hours/week**
	Year: ND 1 Semester:2nd	**Pre-requisite: Introduction to Geology**		**Practical: 2 hours/week**

General Objectives

1. Understand stratigraphy
2. Appreciate dating methods
3. Know stratigraphic nomenclature
4. Know geologic time scale
5. Know facies
6. Understand sedimentary environment
7. Know unconformities
8. Understand correlation of stratigraphic events

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

	Course: Stratigraphy		**Course Code: MPE 106**		**Contact Hours: 3**	
					Theoretical:1 hours/week	
	Year: ND 1 Semester: 2nd		**Pre-requisite:**		**Practical:2 hours/week**	
	Theoretical Content			**Practical Content**		
Week	**General Objective 1.0: Understand stratigraphy**					
	Special Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
1-2	1.1 State the following laws (i) Law of Uniformitarianism (ii) Law of superimposition	1. Develop instructional manual for teaching this course. 2. Define stratigraphy 3. Explain the laws of Uniformitarianism and superimposition	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 2.0: Appreciate dating methods					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
3-4	2.2 Explain the following dating methods i. Radiometric method ii. Fossil assemblage iii. Use of index fossils iv. Succession of strata	1. Distinguish between various dating methods 2. Evaluate the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip	Draw and label major fossil-types (e g Macro-types like Gastropod, ammonites, and micro-types like Foraminifera, etc).	• Develop practical manual for laboratory/workshop exercises in this course. • Prepare practical as indicated in the	Practical Manual. Journals Diagrams/ Sketches

			charts, etc.		manual. • Explain major fossil types,	
	General Objective 3.0: Know stratigraphic nomenclature					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
	3.1 Define i. Time Stratigraphy ii. Rock-Stratigraphy iii. Geologic Time Units 3.2 Explain the terms in 3.1. above	1. Differentiate the terms in 3.1	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 4.0:Know the geologic time scale					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
	4.1 Explain the term "Geologic time scale " 4.2 Explain the following time scales: Era, Period, Epoch, age, group systems, series and stage.	1. Give the historical development of geologic time scale 2. Explain the differences among the various time scales, era, period, epoch etc 3. Evaluate the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 5.0:Know facies					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
5	5.1 Define facies 5.2 Describe association of facies 5.3 State Walter's Law of facies association. 1.2 State types of facies	1. Explain facies using Walter's law of facies association 2. Asses the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 6.0: Understand sedimentary environment					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
6	6.1 Explain with illustrations the following sedimentary environment: (i) marine environment (ii) transition environment (iii) continental environment	1. Describe the term "sedimentary environment"	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	Identify field out crop (e.g. shelly lime, sandstone, etc) using visual, petrological, and chemical methods	• Develop practical manual for laboratory/workshop exercises in this course. • Prepare practical as indicated in the manual	Practical Manual.
	General Objective 7.0:Know Unconformities					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
7-8	7.1 Explain with illustrations, the following unconformities: (i) Non-conformity (ii) Angular unconformity (iii) Disconformity	1. Differentiate the various types of unconformities 2. Assess the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint	Draw geological map and construct stratigraphic cross-sections	Identify field outcrop and ask them to construct geological map and stratigraphic cross-sections	Practical Manual.

	(iv) Parallel unconformity (v) Composite unconformity.		Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 8.0: Understand correlation of stratigraphic events					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
9-11	8.1 Explain with illustration correlation based on: (i) Lithologic similarity (ii) Paleontologic similarity	1. Describe stratigraphic events 2. Assess the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	Correlate log - sections of boreholes	correlate log-sections of bore-holes	Practical Manual. Log books
	ASSESSMENT: The continuous assessments, tests and quizzes will be awarded 40%, while the remaining 60% will be for the end of the Semester Examination Score.					

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

	Department/Programme: ND Minerals and Petroleum Resources Engineering	**Course Code: MPE 201**		**Contact Hours: 5**
	Subject/Course: Mineralogy and Petrology			**Theoretical: 2 hours/week**
	Year: ND II Semester:1st	**Pre-requisite: Introduction to Geology**		**Practical: 3 hours/week**

General Objectives:

1. Understand the various occurrences of minerals
2. Know various rock types
3. Know the genesis of minerals
4. Know the classification and physical properties of minerals.
5. Understand crystallography.
6. Know optical mineralogy.

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

	Course: Mineralogy and Petrology		**Course Code: MPE 201**		**Contact Hours: 5**	
					Theoretical:2 hours/week	
	Year: ND II Semester: 1st		**Pre-requisite: MPE 103 Introduction to Geology**		**Practical:3 hours/week**	
	Theoretical Content		**Practical Content**			
Week	**General Objective 1.0: Understand the geneses and occurrences of various minerals**					
	Specific Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
1-3	1.2 Review the distribution and abundance of chemical elements in the earth's crust 1.3 Define mineralogy 1.4 Define mineral a. Explain silicate - structured rock - forming minerals. b. Describe the occurrence of 1.2 above.	1. Develop instructional manual for teaching this course. 2. List types of mineral 3. Describe silicate - structured rock - forming minerals and their occurrences. 4. Assess the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	7.1 Identify rock-forming minerals in hand specimen and under petrological microscope.	• Develop practical manual for laboratory/workshop exercises in this course. • Prepare practical as indicated in the manual	Practical Manual. Petrological Microscopes Rock Specimens.
	General Objective 2.0: Know the classification and physical properties of minerals					
	Specific Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
	2.1 Distinguish between rock-forming and non-rock forming minerals. 2.2 State common silicates and their classes e.g. neso-silicates, soro-silicates, ino-silicates, phyllo-silicates, etc) 2.3 Classify minerals into common groups, giving examples (eg native elements, oxides, sulphides, silicates, etc.). 2.4 Enumerate the non-silicate groups with examples. 2.5 Describe the morphological feature such as crystal lattice form and aggregates. 2.6 Explain common physical features of minerals (e.g. colour, luster, streak, hardness, transparency, magnetism, radio activity, relative density etc.) 2.7 Identify minerals based on the features in 4.6 above 2.8 Test minerals *for* hardness using Mohr's scale. 2.9 Determine relative density of common minerals.	1. Differentiate between rock-forming and non-rock-forming minerals 2. Ask the students to state and classify common minerals into their native groups 3. Evaluate the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			

	General Objective 3.0: Understand crystallography					
	Specific Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
	3.1 Define crystallography. 3.2 List crystallographic reference axes. 3.3 Describe crystal" systems e.g. Cubic, hexagonal, Tetragonal, orthorhombic, monoclinic, Triclinic. 3.4 List examples of minerals crystallizing in the systems in 3.3 above. 3.5 Describe the X-ray crystallographic method of analyzing minerals.	1. Explain crystallography 2. Explain the different crystal systems with diagrams and show examples of minerals exhibiting the various system 3. Evaluate the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	• Examine and identify models of various crystal systems. • Perform learning outcome 3.5 for various minerals	• Prepare practical as indicated in the manual. • Guide students to carryout practical works.	Practical Manual.
	General Objective 4.0: Know optical mineralogy					
	Specific Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
	4.1 Explain properties of light 4.2 Discuss reflection, refraction in relation to refractive in-dex. 4.3 Explain the polarization of light 4.4 Describe isotropic and Anisotropic Minerals 4.5 Describe the petrological microscope and its components. 4.6 Analyze minerals using suitable optical equipment.	1. Describe properties of light and show relationships between refraction and reflection to refractive index 2. Assess the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 5.0: Know various rock types					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
4-5	5.1 Define various rock-types (e.g. igneous rocks) 5.2 Describe mode of formation of igneous rock. 5.3 Classify rocks 5.4 Identify structure and texture associated with igneous rocks. 5.5 List different types of igneous rocks, giving local examples. 5.6 Define sedimentary rocks 5.7 Describe modes of formation of Sedimentary rocks 5.8 Classify 5.6 above 5.9 Identify structure and texture associated with 5.6 5.10 List different types of 5.6	1. Differentiate the various rock types 2. Explain the structures and textures of various rock types 3. Evaluate the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	Identify rock types in hand specimen and under Petrological microscope	• Prepare practical as indicated in the manual. • Guide students to carryout practical works.	

	5.11 Define metamorphic rocks 5.12 Describe types of metamorphism 5.13 Classify 5.11 above 5.14 Identify structure and texture associated with 5.11					
	ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 40% of the total score. The end of the Semester Examination will make up for the remaining 60% of the total score.					

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

	Department/Programme: ND Minerals and Petroleum Resources Engineering	**Course Code: MPE 203**		**Contact Hours: 5**
	Subject/Course: Mineral Processing and Extractive Metallurgy			**Theoretical: 2 hours/week**
	Year: ND II Semester:1st	**Pre-requisite: Introduction To Mineral Processing Technology**		**Practical: 3 hours/week**

General Objectives:

1. Understand simple calculations carried out in the mill
2. Know ore sorting techniques
3. Understand magnetic separation technique
4. Know electrostatic separation technique.
5. Understand froth flotation technique.
6. Know gravity separation technique
7. Know auxiliary milling operations
8. Understand the principles of extractive metallurgy techniques

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING						
Course: Mineral Processing and Extractive Metallurgy		**Course Code: MPE 203**	**Contact Hours 5HRS/WEEK**			
Course Specification: Theory				**Practical**		
Week	**General Objective 1.0: Understand simple calculations carried out in the mill**					
	Specific Learning Outcome:	**Teacher Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
1-2	1.1 Explain the material balance equation, F= C+T. 1.2 Define concentration Ratio 1.3 Give an expression for 1.2 above 1.4 Define Recovery 1.5 Give an expression for 1.4 above 1.6 Explain the terms (i) Losses in tailings (ii) Circulating load (iii) Pulp density (iv) Screening efficiency	1. Develop instructional manual for teaching this course. 2. Deduce material balance equation 3. Explain the terms; concentration ratio, recovery, and explain losses in tailings, circulating load, pulp density and screening efficiency.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objectives: 2.0: Know ore sorting techniques					
	Specific Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
	3.1 Explain the principles of hand and mechanical sorting 3.2 Enumerate the importance of sorting in mineral ,processing	1. Describe hand sorting 2. Explain mechanical sorting and enumerate its various types 3. State the importance of sorting mineral processing	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	Demonstrate hand sorting	1. Develop practical manual for laboratory/workshop exercises in this course. 2. Prepare the sample 3. Supervise the practical 4. Assess the students practical work book	Practical Manual. Mineral samples, sorting tables, light source, etc.
	General Objective 3.0: Understand magnetic separation technique					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
3-4	3.1 Describe magnetic separation principle 3.2 List ores susceptible to magnetic separation 3.3 Describe the separation condition applicable to ores in 2.2 above. 3.4 List equipment used in magnetic separation eg; drum, induced roll, cross belt, wet high and low intensity magnetic separators. 3.5 Identify the equipment listed in 2.4 above. 3.6	1. Explain the principle of magnetic separation. 2. Explain the various types of equipment used in magnetic separation. 3. Describe the application of low intensity and high intensity machines 4. Evaluate the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	Conduct magnetic separation of ore(s)	1. Prepare the sample 2. Supervise the practical 3. Assess the students practical work book	Mineral samples, Magnetic separator. Practical Manual.

	General Objective 4.0: Know electro static separation technique					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
5-6	4.1 State the importance of electrostatic separation methods. 4.2 Enumerate electrostatic methods of ore separation. 4.3 Explain the principles underlying the various elec-trostatic separation methods. 4.4 List equipment used in electrostatic separation e.g. high tension roll, screen plate, plate separators, etc.	1. Explain the theory of electro static separation. 2. Evaluate the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	Conduct electrostatic separation of ores	1. Prepare the sample 2. Supervise the practical 3. Assess the students practical work book	Mineral samples, electrostatic machine. Practical Manual.
	General Objective 5.0: Understand froth – flotation technique					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
7-8	5.1 Describe froth flotation 5.2 List applications of 4.1 above 5.3 Enumerate flotation reagents	1. Define froth flotation. 2. List minerals that are self-floating and those that require change in their surface behavior through reagent to be able to float 3. Asses the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	Carry out practical on froth floatation	1. Prepare the sample 2. Supervise the practical 3. Assess the students practical work book	Practical Manual. Flotation cell, flotation machine, scraper, oven, flotation reagents, minerals samples etc.
	General Objective 6.0: Know gravity separation technique					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
9	6.1 Describe the gravity separation principle 6.2 Enumerate types of gravity separation 6.3 List equipment used in 5.2 above	1. Describe gravity separation.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	Carryout practical on gravity separation Perform gravity separation of Iron Ore, Tin – oxide etc.	1. Prepare the sample 2. Supervise the practical 3. Assess the students practical work book	Practical Manual. Mineral samples, concentration tables, jigs, sluice box, spirals, hydro cyclones, concentration pans, etc.
	General Objective 7.0:Know auxiliary milling operations					
Weeks	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
10	7.1 Explain washing and filtering 7.2 Describe tailings removal and disposal 7.3 Describe dewatering techniques applied to milling operations	1. Identify ferrous metals 2. Explain the economic importance of ferrous metals to Nigerian economy 3. Asses the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 8.0: Understand the principles of extractive metallurgy techniques					
Weeks	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
11	8.1 Classify metals into ferrous and non-ferrous categories 8.2 List economic minerals from which ferrous and non-ferrous metals are extracted.	1. Discuss ferrous and non-ferrous metals found in Nigeria 2. Describe pyrometallurgy 3. Describe hydrometallurgy	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard,	Demonstrate the application of 8.6, 8.8 and 8.10 above	1. Prepare the sample 2. Supervise the practical 3. Assess the students practical work book	Practical Manual. Laboratory furnace, mineral samples, electrolytic cells,

	8.3 Enumerate where these metals are found in Nigeria 8.4 Define extractive metallurgy 8.5 Enumerate the branches of extractive metallurgy 8.6 Explain the basic principles of pyrometallurgy 8.7 List the criteria used for the selection of pyrometallurgy as an extraction method. 8.8 Explain the principle of hydrometallurgy 8.9 List the criteria use for the selection of hydrometallurgy as an extraction method 8.10 Describe the basic principle of electrometallurgy 8.11 List the criteria use for the selection of electrometallurgy as an extraction method	4. Describe electrometallurgy	PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			reagents, etc.
	ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 40% of the total score. The end of the Semester Examination will make up for the remaining 60% of the total score.					

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

	Department/Programme: ND Minerals and Petroleum Resources Engineering	**Course Code: MPE 205**		**Contact Hours: 5**
	Subject/Course: Petroleum Drilling Technology			**Theoretical: 2 hours/week**
	Year: ND II Semester:1st	**Pre-requisite:**	**-**	**Practical: 3 hours/week**

General Objectives:

1. Understand drilling technology concept.
2. Understand types of drilling and hole problems
3. Understand formation pressure
4. Understand drilling fluid
5. Understand cementing and work over operation methods in drilling
6. Understand drilling Completion

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

PROGRAMME: NATIONAL DIPLOMA MINERAL RESOURCES ENGINEERING						
Course: PETROLEUM DRILLING TECHNOLOGY	**Course Code: MRE 205**	**Contact Hours 5HRS/WEEK**				
Course Specification: Theory				**Practical Content**		
Week	**General Objective 1.0: Understand drilling technology concept.**					
	Specific Learning Outcome:	**Teacher Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
1-4	1.1 Define oil and gas wells 1.2 State types of oil and gas wells 1.3 State general drilling methods (e.g. percussion, rotary, etc). 1.4 Describe the methods in 1.3 above. 1.5 Outline types of drilling rigs (e.g. Onshore and offshore etc). 1.6 Describe five components of a drilling rig. 1.7 Describe the purpose, design and main parts of rotary rig. 1.8 Describe the types and design principles of drill Bits. . 1.9 Explain the factors influencing the selection of drill bits. 1.10 Describe the drill string and its components. 1.11 Describe the functions of 1.9 above. 1.12 Describe prime movers, draw works, blocks, etc~ and the efficiency of the drill line. 1.13 Explain the factors affecting drilling, ego weight on bit, rotary speed, hydraulic factors, etc.	1. Develop instructional manual for teaching this course. 2. Explain the processes and stages of drilling 3. Explain the criteria for design and selection of drilling bits. 4. Assess the students on the concept of drilling technology.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	1. Carryout computer simulation on drilling operation 2. Conduct field trip on either on shore or off shore rig. 3. Write a report on 1-2 above	1. Develop instructional manual for teaching this course. 2. Supervise students 3. Coordinate field trip 4. Evaluate students on reports submitted.	Practical Manual. Films, Related computer software, OHP, computer + accessories, internet etc.
	General Objective 2.0 Understand types of drilling and hole problems					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**

	1.1 Categorize different types of holes viz; straight, crooked, and directional holes. 1.2 Describe the following hole problems: a. lost circulation b. pipe sticking c. shale sloughing d. formation damage	1. Explain the different types of holes. 2. Explain the different types of drilling. 3. Explain the various types of formation.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 3.0: Understand formation pressure					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
5-7	3.1 Explain how well-bore pressure develops viz normal, subnormal, and abnormal pressures. 3.2 Explain the hydrostatic, static, circulating and equivalent circulating pressures. 3.3 Explain how to detect blow-outs. 3.4 Explain the control of blow-out. 3.5 Describe the types, mechanisms, operations and pressure ratings of blowout preventers.	1. Assess students on the understanding of formation pressure.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 4.0: Understand drilling fluid					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
8-9	4.1 Explain the purposes and functions of drilling fluids. 4.2 Outline tests procedures for drilling mud properties. 4.3 Explain the engineering data and calculations involved in the 3.2 above. 4.4 Explain composition and properties of clay-water muds. 4.5 Describe the characteristics and specifications of clay mixtures. 4.6 Describe the mud-pump; d-Exponent and shale factor; dc-Exponent and mud circulation	1. Explain the importance of drilling fluids and the circulating system. 2. Assess students on the understanding of circulation of fluid in drilling.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	1. Conduct test on mud properties 2. Measure mud viscosity and porosity.	1. Prepare a drilling mud. 2. Supervise practical work 3. Assess students	Practical manual, Mixing machine, Mash cup, mud balance, measuring balance, thermometer, PH, oven hydrometer etc.
	General Objective 5.0: Understand cementing and work over operation methods in drilling					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**

10-12	4.1 Describe squeeze cementing under the following headings: - nature of cement and porous system. - cement and additives used for squeezing. - high and low pressure techniques. - testing the job success. 4.2 Explain other squeeze operations; open hole and casing plugs, and small pipe cementing (concentric cementing) . 4.3 Explain the significance of fishing during walkovers, plug backs, and side tracking. 4.4 Describe fishing tools and procedure.	1. Explain squeeze operations; open hole and casing plugs, and small pipe cementing 2. Explain the significance of fishing during walkovers, plug backs, and side tracking and describe fishing tools and procedure	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	Watch documentary or video film on onshore and offshore operation.	Supervise film/video presentation.	Practical Manual. Films, OHP, computers and access internet etc.
	General Objective 6.0: Understand drilling completion					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
13-14	6.1 Explain methods of preparing weJI for completion eg: Single stage, dual stage, multiple zone, open hole, and liner completions, perforated casing com-pletion. 6.2 Explain well perforation 6.3 Describe subsurface equipment such as tubing and nipples; packers, joint subs, flow coupling, and sleeves, etc.	1. Describe the operation on well completion 2. Explain the various role of subsurface equipment 3. Assess students on drilling completion.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 40% of the total score. The end of the Semester Examination will make up for the remaining 60% of the total score.					

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

	Department/Programme: ND Minerals and Petroleum Resources Engineering	**Course Code: MPE 207**		**Contact Hours: 4**
	Subject/Course: Basic Surveying			**Theoretical:1 hours/week**
	Year: ND II Semester: 1st	**Pre-requisite:**	**-**	**Practical: 3 hours/week**

General Objectives

1.0 Know fundamental concepts of surveying

2.0 Appreciate surveying trigonometry

3.0 Know basic survey drawing techniques

4.0 Understand leveling

5.0 Know traversing

6.0 Know triangulation

7.0 Know tachometry

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING						
Course: Basic Surveying		**CODE: MPE 207**	**CONTACT HOURS: 4 HRS/WK**			
Course Specification: THEORITICAL CONTENT			**PRACTICAL CONTENT**			
Week	**General Objective 1.0: Know the fundamental concepts of surveying.**					
	Specific Learning Outcome:	**Teacher Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
1-2	1.1 Define Surveying 1.2 Distinguish between the following major divisions of surveying: (i) geodetic surveying (ii) plane surveying 1.3 State the uses of plane surveying (e.g. maps and plans, geographical, geological engineering, military purpose etc,) . 1.4 Explain the three stages of surveying process. (i) reconnaissance (ii) observation and measurement (iii) presentation 1.5 Illustrate the basic principles of surveying measurements (linear and angular) 1.6 State the branches of surveying in mineral exploration and exploitation.	1. Develop instructional manual for teaching this course. 2. Explain the fundamental concepts of surveying. 3. Explain the relevance of surveying to mining industry and the various professions where surveying is significant	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 2.0: Appreciate surveying trigonometry.					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
3	1. Review trigonometric ratios of common angles. 2. Solve problems involving triangles (sine rule, cosine rule, area of triangle, Napier's tangent rule).	1. Revise trigonometric ratios and solve problems involving triangles 2. Evaluate the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 3.0: Know basic survey drawing techniques					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
4	3.1 Explain the use of scales and handling of other drawing instruments.	1. Explain the use of basic survey drawing techniques 2. Evaluate the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	• Identify all the drawing instruments (compasses, dividers, protractors, set squares, pencil, etc.) • Demonstrate the simple procedure for ink-drawing and lettering techniques	• Develop practical manual for laboratory/workshop exercises in this course. • Prepare practical as indicated in the manual	Practical Manual. Drawing set, drawing board, drawing paper

	General Objective 4.0: Understand leveling					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
5-7	4.1 Define leveling 4.2 Explain the following terms related to leveling: datum; level surface, line of collimation, mean sea level, bench mark. 4.3 Describe the basic principle of leveling 4.4 Explain the following leveling procedure: (a) compound leveling (b) flying level (c) profile leveling (d) reciprocal leveling. 4.5 Explain the reduction of leveling results by (a) rise and fall method, and (b) height of collimation method. 4.6 Describe the effect of each curvature and atmospheric refraction on leveling. 4.7 State typical errors that may occur in leveling.	1. Explain the terms related to leveling 2. Describe basic principles of leveling 3. Evaluate the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	Measure horizontal and vertical angels using theodolite.	• Develop practical manual for laboratory/workshop exercises in this course. • Prepare practical as indicated in the manual. • Identify working components of theodolite and measure horizontal and vertical angles with theodolite.	Practical Manual. Theodolite, ranging rods, ranging staff, survey record book
	General Objective 5.0: Know traversing					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
8-10	5.1 Define Traversing. 5.2 Describe the principle of traversing 5.3 Explain the methods of adjustment of closed traverses, - Bowditch method and transit method. 5.4 Perform calculations of bearings, distances and Co-ordinates from traverse surveys	1. Explain the concept of traversing 2. Solve problems of bearings, distances and coordinates from traverse surveys.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 6.0: Know triangulation					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
11-12	6.1 Define triangulation 6.2 Describe the principle of triangulation 6.3 State application of triangulation 6.4 Explain methods of measurement of triangulation angles (re-iteration and repetition	1. Describe the triangulation principles and its methods of measurement 2. Asses the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			

	methods) 6.5 Explain methods for adjusting values of triangulation angles (triangle, braised quadrilateral and polygonal adjustments). 6.6 Write angular observations in conventional forms.					
	General Objective 7.0: Know tachometry					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
13-14	7.1 Define tachometry 7.2 Describe the principle of the stadia-system (fixed-hair and sub tense tachometers) 7.3 Describe the determination of tachometric constants. 7.4 Describe the sub tense system 7.5 Outline the optical wedge system. 7.6 Explain tachometric methods for plotting contours	1. Explain the concept tachometry, 2. Describe the determination of tachometric constants and 3. Describe sub tense system 4. Asses the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	• Conduct a tachometric exercise. • Determine tachometric constants from field measurement. • Plot contours from tachometric measurements in 7.8 above.	• Develop practical manual for laboratory/workshop exercises in this course. • Prepare practical as indicated in the manual	Practical Manual. Theodolite, Tachometers Staff Ranging Poles
	ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 40% of the total score. The end of the Semester Examination will make up for the remaining 60% of the total score.					

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

	Department/Programme: ND Minerals and Petroleum Resources Engineering	**Course Code: MPE 209**		**Contact Hours: 3**
	Subject/Course: Mining Methods			**Theoretical:1 hours/week**
	Year: ND II Semester: 1st	**Pre-requisite:**	**-**	**Practical: 2 hours/week**

General Objectives

1.0 Understand the basic elements of open pit operations

2.0 Understand quarrying and glory-holing

3.0 Know materials handling methods in surface mining

4.0 Understand underground mine developments

5.0 Know the underground mining of metalliferrous

6.0 Know the underground mining of stratified deposits

7.0 Understand the underground mining equipment for stratified deposits

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING						
Course: Mining Methods	**CODE: MPE 209**	**CONTACT HOURS: 3 HRS/WK**				
Course Specification: THEORITICAL CONTENT			**PRACTICAL CONTENT**			
Week	**General Objective 1.0: Understand the basic elements of open pit operations**					
	Specific Learning Outcome:	**Teacher Activities**	**Resources**	**Specific Learning Outcome:**	**Teacher Activities**	**Resources**
1-3	1.1 Define open-pit mine. 1.2 Explain with illustration the following features of 1.1 above. - Pit floor - Toe - Bench (height and width) - Pit face - Better or slope angle, etc. 1.3 Enumerate factors that influence open pit operation e.g. nature of overburden, depth of overburden, machinery available, size of deposit, labour availability, proximity of market, etc). 1.4 Describe the following methods of developing: - open-pit mine - Box-cut - Benching - Stripping 1.5 Describe briefly the application of the following machineries in open-pit operation: (i) Tractor shovel (front-End-Loader) (ii) Bulldozer ripper (iii) Scrapers (iv) Bucket-wheel excavators (v) Bucket chain excavators (vi) Power shovels (vii) Draglines (viii) Trucks. 1.6 Explain how the equipment in 1.5 above are used in extracting the Ore-body.	1. Develop instructional manual for teaching this course. 2. Define and enumerate factors that influence open pit mine 3. Describe factors that dictate the approach to be used for mine development 4. Explain the use of mine machineries for mining of deposit using open-pit method	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 2.0: Understand quarrying and glory-holing					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
4-5	2.1 Classify quarrying into: (i) Rock breaking using explosive and without explosive (saving). (ii) Scooping of gravels from river beds or lakes 2.2 Describe the general operation of a quarry.	1. Describe quarrying operation 2. Illustrate diagrammatically quarry works depicting all the features	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint			

	2.3 Draw and label a flow diagram showing various quarry-works from pit to final product. 2.4 Describe glory-hole mining and compare with quarrying.		Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 3.0: Know materials handling methods in surface mining					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
6-7	3.1 Describe the following modes of transportation: -Locomotives - Belt conveyors - Skip haulage - Aerial Ropeways - Aerial cableways - Trucks - Loader. 3.2 Explain how two or more modes of transportation in 3.1 above may be combined to form a transpor-tation system. 3.3 Itemize the storage facilities used in surface mining	1. Describe the modes of transportation 2. Give reasons for using more than one mode of transportation system in mining 3. Explain the operations of storage facilities used in surface mining 4. Evaluate the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 4.0: Understand underground mine developments.					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
8-9	4.1 Describe the following features of mine development: shaft, adit, declines, inclines, sub-inclines, so-lution mining. 4.2 Compare the features in 4.1 above. *4.3* Explain the following factors determining choice of mode of entry and development: size of equipment, economic factors, dip of the Ore-body, nature of arrangement 4.4 Explain the factors governing the number of entries and their location in the following aspects: - Ventilation and safety -Required output - 'Costs - Mode of formation of Ore bodies - Method of underground haulage 4.5 Describe the methods of drifting, cross-cutting, raising, winze, shaft sinking, etc, (Conventional methods, TBM and Raise Borers). 4.6 Describe the following drilling patterns in soft and' hand rock mining.	1. Describe the following features of mine develop 2. Explain the factors determining choice of mode of entry and development: size of equipment, economic factors, dip of the Ore-body, nature of arrangement 3. Describe the methods of drifting, cross-cutting, drilling patterns, and mucking operations in development and production	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			

	- Burn cut - Draw cut - Wedge cut - V - cut - Pyramid cut - fan cut 4.7 Describe mucking operation in development and production.					
	General Objective 5.0: Know the underground mining of metalliferrous					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
10-11	5.1 Outline factors determining choice of underground mining methods (e.g. shape, size, regularity, dip of ore-body, mineralogical and physical characteristics, distribution of Ore-body, value of Ore, relationship of deposit to surface and other deposits, type and availability of equipment. 5.2 Explain the effect of the factors in 5.1 on choice of underground method of mining. 5.3 Describe the following underground metalliferrous mining methods: (a) Open stopes (Underhand and overhand stopes) . (b) Shrinkage stopes (c) Square set stopes (d) Cut-and-fill stopes (e) Caved stopes (block and sub-level caving) (f) Breast stoping. 5.4 Classify the methods in 5.3 from wall support point of view. 5.5 Illustrate the methods in 5.4 with sectional and plan diagrams.	1. State factors determining choice of underground mining methods (e.g. shape, size, regularity, dip of ore-body, mineralogical and physical characteristics, distribution of Ore-body, value of Ore, and relationship of deposit to surface and other deposits, type and availability of equipment.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 6.0: Understand underground mining of stratified deposits.					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
12-13	6.1 Describe the following methods of mining: (a) Room-and-Pillar (b) Short wall (c) Long wall (d) Advancing (e) Retreating. 6.2 Explain the following factors influencing choice of method: (a) nature of roof and floor (b) depth of seam (c) thickness of seam (d) geological and physical	• Describe mining methods and the factors influencing the choice of mining method. • Sketch a typical layout of plan and section of each method for stratified deposit	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			

	conditions of seam (e) current local practices (f) Presence of explosive gases and dust. (g) product desired. 6.3 Enumerate factors determining width of headings and size of pillars. 6.4 Explain panel and conventional systems. 6.5 List the advantages of panel system over conventional system. 6.6 Compare Long wall advancing with long wall retreating method.					
	General Objective 7.0: Understand underground mining of stratified deposits.					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
14	7.1 Describe the principal constructional features of cutting machineries. 7.2 List the types of cutters and picks (eg. carbon steel, satellite tipped, carbide insert, etc). 7.3 Describe the pick sequences and cutting pattern 7.4 Describe the following types of loaders and state their applications: - Slushier." - Gathering arm - Rocker arm" - Load-haul-Dump (LHD)	1. Explain the principal features of cutting machineries, and list the types of cutting tools. 2. describe the types of loaders and state their applications. 3. Evaluation the students.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 40% of the total score. The end of the Semester Examination will make up for the remaining 60% of the total score.					

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

	Department/Programme: ND Minerals and Petroleum Resources Engineering	**Course Code: MPE 202**		**Contact Hours: Two**
	Subject/Course: Prospecting and Exploration of Deposits			**Theoretical: hours/week**
	Year: Two Semester: First	**Pre-requisite: MPE 105**		**Practical: hours/week**

General Objectives

1. Understand prospecting methods
2. Know geographical methods of mineral exploration
3. Understand exploration by drilling
4. Know geological prospecting methods
5. Understand calculations of Ore Reserves in Mineral Valuation
6. Understand calculations of ore and hydrocarbon reserves.

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING						
Course: PROSPECTING AND EXPLORATION OF DEPOSITS		**Course Code: MPE 202**		**Contact Hours 2HRS/WEEK**		
Course Specification: Theory, Practical and Field Trip						
Week	**General Objective 1.0: Understand prospecting**					
	Specific Learning Outcome:	**Teacher Activities**	**Resources**	**Specific Learning Outcome:**	**Teacher Activities**	**Resources**
1-5	1.1 Define prospecting 1.2 Enumerate various prospecting methods for mineral deposits 1.3 Enumerate various prospecting methods for hydrocarbon deposits 1.4 Explain the application of each method in 1.2 and 1.3	1. Develop instructional manual for teaching this course. 2. Explain geological, geochemical, aerial, glacial float tracing, panning and geo-botanical methods	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.		Develop practical manual for laboratory/workshop exercises in this course.	
	General Objective 2.0: Know geological prospecting methods					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
6-8	2.1 List geological prospecting methods. 2.2 Explain the methods in 2.1 above 2.3 Describe various methods of collecting, presenting, and interpreting data from 2.1 above	1. Describe surface geological mapping, trenching, pitting, panning, etc 2. Explain the sedimentary environments favourable to generation, migration and accumulation of hydrocarbons.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 3.0: Know geophysical methods of exploration					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teacher Activities**	**Resources**
9-11	3.1 List various geophysical methods of exploration e.g. seismic, gravity, magnetic, and electrical. 3.2 Explain the principles involved in each of the methods in 3.1. 3.3 Describe various methods of collecting data from geophysical instruments such as magnetometer, gravimeter, seismometer etc. 3.4 Using geophysical data explain how to estimate of ore/hydrocarbon reserves, e.g. thickness of overburden, velocity and resistivity in rock, etc.	1. Explain geophysical exploration techniques. 2. Describe geophysical instruments. 3. Solve problems on ore/hydrocarbon reserve estimation.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	Select and apply the most appropriate method for a given situation in the field	Anchor site visit. Supervise students during and after the trip. Assess students' report on the field trip exercise.	Practical Manual.
	General Objective 4.0: Know geochemical methods of exploration					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teacher Activities**	**Resources**
12-15	4.1 List the various geochemical methods, e.g. soil survey, stream sediment survey, geo-botanical and biogeochemical surveys. 4.2 Explain the principles involved in 4.1 above 4.3 Describe the various methods of	1. Describe the various geochemical methods. 2. Explain the equipments used in 4.3. 3. Explain sample preparation procedure.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	▪ Perform geochemical investigation using appropriate method on samples. ▪ Submit report on experiences during the trip.	Anchor site visit. Assess students' report on the field trip exercise.	Practical Manual. Soil sample; Rock sample; Sample Bag; Hand Auger; Penetrometer; Morter; Crucibles;

	collecting geochemical data from instruments such as hand auger, standard penetrometer, Ph meter, Voltmeter etc. 4.4 Describe geochemical sample analytical methods. 4.5 Describe sample preparation procedure. ○ driving, sieving, grinding, and quartering ○ crushing					Reagents; Bunsen Burner
	General Objective 5.0: Understand exploration by drilling					
	Specific Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
	5.1 Explain exploration grid. 5.2 State types of exploration grids – (a) regular grids e.g. square, rectangular, rhomboid (b) irregular grids. 5.3 Explain 5.2 above and relate to solid minerals and hydrocarbon exploitation. 5.4 Describe drilling methods (Diamond and Banka) 5.5 State types of drilling bits, e.g. diamond, tungsten carbide, hard alloys etc. 5.6 Explain geological logging of borehole cores. 5.7 Classify mineral and hydrocarbon reserves based on geo-scientific information.	1. Explain the concept of exploration by drilling. 2. Explain the properties and application of the various drilling bits. 3. Interpret geo-scientific information using borehole log.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	○ Carryout field trips to a drilling site. ○ Identify components of drill rig. ○ Observe drilling operation. ○ Submit report on experiences during the trip.	Anchor site visit. Explain activities at the drill site. Supervise students during and after the trip. Assess students' report on the field trip exercise.	Transport. Audio Visual Aids. Practical Manual.
	General Objective 6.0: Understand calculations of ore and hydrocarbon reserves.					
	Specific Learning Outcome:	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
	6.1 Explain geological logging of well and borehole cores. 6.2 Enumerate the exploration procedure and data analysis prior to evaluation. 6.3 Explain area of influence of borehole in estimation of ore and hydrocarbon reserves. 6.4 Estimate ore reserves from borehole data. 6.5 Explain reserve estimation of oil and gas in place.	1. List the procedure for geological logging of borehole. 2. State the importance of borehole area of influence. 3. Explain the use of borehole data. 4. Explain material balance and volumetric equations in hydrocarbon reserve estimation in standard units of barrel for oil and cubic feet for gas.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	○ Perform simple calculations of reserve estimation. ○ Calculate tonnage, barrels, cubic feet of gas and average assay value.	Provide data for calculation. Guide students on procedure for calculation. Assess students' results.	Practical Manual. Well log data Calculators Internet Resources. Computers and Peripherals.
ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 40% of the total score. The end of the Semester Examination will make up for the remaining 60% of the total score.						

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

	Department/Programme: ND Minerals and Petroleum Resources Engineering	**Course Code: MPE 204**		**Contact Hours: 5**
	Subject/Course: Structural and Field Geology			**Theoretical: 2 hours/week**
	Year: ND II Semester: 2nd	**Pre-requisite:**	**-**	**Practical: 3 hours/week**

General Objectives:

1. Understand stress and strain
2. Understand fracturing of rocks
3. Appreciate folds
4. Know Geological maps, sections and field work

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING						
Course: STRUCTURAL AND FIELD GEOLOGY	**Course Code: MPE 204**	**Contact Hours 4HRS/WEEK**				
Course Specification: THEORITICAL CONTENT				**PRACTICAL CONTENT**		
Week	**General Objective 1.0: Understand stress and strain**					
	Specific Learning Outcome:	**Teacher Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
1-2	1.1 Define stress and strain 1.2 Give examples of various types of stress and strain (e.g. tensile, compressive, shear). 1.3 Describe and illustrate the response of rock to stress (ductile and brittle behavior). 1.4 Define strike and dip. 1.5 Illustrate strike and dip with a compass and clinometers	1. Develop instructional manual for teaching this course. 2. Define stress and strain and give examples 3. Describe and illustrate the response of rock of stress 4. Illustrate strike and dip with compass and clinometers	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 2.0:Understand fracturing of rocks					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
3-6	2.1 Define faults and joints 2.2 Differentiate between faults and joints. 2.3 Identify various forms of fractures (joints, faults). 2.4 Classify with illustration fractures and joints 2.5 List mineral deposits associated with faults and joints, (including local examples). 2.6 Explain Cleavage. 2.7 Explain structural control of Ore formation and em-placement. 2.8 Explain the importance of these fractures in Mining (joint systems in blasting patterns, faults in mine development, etc).	1. Define faults and joints 2. Differentiate between faults and joints 3. Illustrate fractures and joints 4. List minerals associated with faults and joints.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 3.0: Appreciate folds					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
7-9	3.1 Define folds 3.2 Classify folds (anticlines, synclines) 3.3 Describe fold formation. . 3.4 Illustrate fold elements (e.g. axial plane, fold	1. Define folds 1. Classify folds 2. describe fold formation 3. illustrate fold elements and list minerals associated with fold 4. Evaluate the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic			

	axis, plunges etc. 3.5 List minerals associated with fold, e.g. Salt		Board, flip charts, etc.			
	General Objective 4.0: Know Geological maps, sections and field work					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	
10-14	4.1 Identify the use of different types of scales (statement scales, linear scales) 4.2 Distinguish between topographical maps and geo-logical maps.	Explain 4.1 – 4.2	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	4.1 Construct geological sections from contoured geo. logical maps. 4.2 Interpret geological sections and maps involving horizontal and dipping strata, faults, folds and un conformities. 4.3 Solve three-point problems. 4.4 Identify structures from aerial photographs	1. Develop practical manual for laboratory/workshop exercises in this course. 2. Prepare practical as indicated in the manual. 3. Guide the students on 4.1 to 4.6 4. Identify and discuss different types of geological maps and scales. 5. Asses the students work.	Practical Manual. Drawing paper, pencils, ink, eraser, drawing board, tempo writers (assorted colours), reference chart of the earth's structure Safety helmets, safety boots, first aid facilities, field vehicle, GPS, geological hammer, sample bags, topographic maps, clinometers, Measuring Tapes
	ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 40% of the total score. The end of the Semester Examination will make up for the remaining 60% of the total score.					

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

	Department/Programme: ND Minerals and Petroleum Resources Engineering	**Course Code: MPE 206**		**Contact Hours: 5**
	Subject/Course: Petroleum Production Technology			**Theoretical:2 hours/week**
	Year: ND II Semester: 1st	**Pre-requisite:**	**-**	**Practical: 3 hours/week**

General Objectives

1. Understand oil production techniques
2. Know well-head equipment and their uses
3. Know oil-field development
4. Know gas production.
5. Understand oil and gas measurement
6. Know tank-farm layout, gauging and sampling
7. Understand off-shore and swamp production
8. Understand off-shore loading facilities

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING

PROGRAMME: NATIONAL DIPLOMA IN MINERAL AND PETROLEUM RESOURCES ENGINEERING						
Course: Petroleum Production Technology	**Course Code: MPE 206**	**Contact Hours 5hrs/Week**				
Course Specification: Theory			**Practical Section**			
Week	**General Objective 1.0: Understand oil production techniques**					
	Specific Learning Outcome:	**Teacher Activities**	**Resources**	**Specific Learning Outcome:**	**Teacher Activities**	**Resources**
1	1.1 Explain the principle of the following - producing strata; - water drive - Dissolved Gas drive - Gas cap drive. 1.2 Describe the determination of Oil-in-place vis a vis recoverable reserves 1.3 Describe lifting methods:- gas-lift, liquid-lift. 1.4 Describe pumping technique: - Sucker rod, Rod less pumping. 1.5 Explain production capacity of *oil* well by use of productivity index (PI). 1.6 Explain the inflow performance relationship (Natural flow-flowing gradient). 1.7 Discuss factors important in controlling flowing life. 1.8 Explain special forms of flowing wells 1.9 Describe the method of plugging wells. 1.10 Explain the following secondary recovery tech-niques: - Water drive - Stream drive - Gas Injection - In-Situ combustion.	▪ Develop instructional manual for teaching this course. • Explain oil production techniques. • Demonstrate activities in 2.1 • Explain secondary oil recovery	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 2.0: Know well-head equipment and their uses					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
8-9	2.1 Identify the following: - Casing head flanges - Casing bottom flanges - Tubing head - Tubing hangers - Spools related to casing strings - Adaptor flanges	1. Explain well-head equipment and their uses.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen,	1. Carry out field trip 2. Watch documentary films	1. Develop practical manual for laboratory/workshop exercises in this course. 2. Coordinate field trips 3. Anchor viewing of films	Practical Manual. Transportation bus, films, internet, computers, OHP, audio visual aids

	- Christmas tree 2.2 Explain the significance of 7.1 in production		Magnetic Board, flip charts, etc.			
	General Objective 3.0: Know oil-field development					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
4	3.4 Explain the development of well, flow lines, flow stations, Oil discharge lines, Terminals and tank farms, and Pipelines.	1. Explain oil field development.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 4.0: Know gas production.					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
5	4.4 Explain the following: (i) Gas wells completion, (ii)gathering, (iii) processing, (iv)storage and (v)transportation	1. Explain gas production.	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.			
	General Objective 5.0: Understand oil and gas measurement					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
6	5.1 Discuss methods of oil well-testing and sampling 5.2 State the various specifications of crude oil (e.g.SG, BS and W, Temperature). 5.3 Explain Gas measurements by density, specific gravity, and Orifice meter calculations. 5.4 Describe meter proving techniques.	1. Explain oil and gas measurements. 2. Asses the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	1. Carry out oil testing and sampling 2. Carry out gas measurement	1. Supervise practical works 2. Assess students on conduct/reports submission	Practical Manual. Thief-cup, thermometer, measuring can, orifice meters, API gravity meters.
	General Objective 6.0: Know tank-farm layout, gauging and sampling					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
7	5.1 Describe the following: (i) Floating roof tanks (ii) Fixed roof tanks (iii) Tank farm layout (iv) Guaging and sampling using heaters and treaters.	1. Explain tank-farm layout, gauging and sampling. 2. Asses the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen,	1. Carryout field trip	1. Coordinate field trip. 2. Assess students' report on field trip.	Practical Manual. Transportation bus, films, software, internet, etc.

			Magnetic Board, flip charts, etc.			
General Objective 7.0: Understand off-shore and swamp production						
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
	7.1 Describe following: - Production platforms - Well-head jackets - Production Barge - Off-shore production testing. 7.2 Explain the relevance of 6.1 above in off-shore production	1. Explain off-shore and swamp production. 2. Asses the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	1. Watch documentary film on off-shore and swamp facilities.	1. Anchor viewing of film 2. Assess students on the understanding of viewed clips, pictures, etc.	Practical Manual. Internet, films, computers, OHP, audio visual aids
	General Objective 8.0: Understand off-shore loading facilities					
Week	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**	**Specific Learning Outcome:**	**Teachers Activities**	**Resources**
10-11	8.1 Describe the following facilities: - Sea loading lines -Floating buoy moorings -Stationary tankers. 8.2 Explain the relevance of 8.1 in off-shore loading.	1.1 Explain off-shore loading facilities 1.2 Asses the students	Instructional Manual. Recommended textbooks, e-Books, lecture notes, Whiteboard, PowerPoint Projector, Screen, Magnetic Board, flip charts, etc.	1. Visit land swamp and off-shore locations. 2. Identify the following: - wells - rigs - flow stations - tank farms etc.	1. Organize field trip for the students 2. Asses the students	Practical Manual. Transportation bus, audio visual aids, etc.
	ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 40% of the total score. The end of the Semester Examination will make up for the remaining 60% of the total score.					

LIST OF JOURNALS FOR THE PROGRAMME

1. Mining Journal
2. Minerals & Metallurgical Processing Journal
3. Transaction of the Institution of Mining & Metallurgy Section A, Mining Technology
4. Industrial Minerals Journal
5. Mining Engineering Journal
6. ICMJ's Prospecting & Mining Journal
7. Chemical Engineering & Processing
8. Computer & Chemical Engineering
9. International Journal of Rocks Mechanics & Mining science
10. Minerals Engineering
11. AIChE Journal

LIST OF RECOMMENDED SOFTWARES FOR THE PROGRAMME

1	Design Expert
2	Intel Visual Fortran
3	COMSOL MULTIPHYSICS
4	ASPENONE 7.1
5	SOLIDWORKS 2010
6	Plate N Sheet Development Software
7	G &P Engineering software PhysProps
8	Mineral Economic Analysis Tools
9	SMINSIM, MSMENU and Data Analysis Reporting Tools
10	PREVAL, a Lotus 1-2-3 based pre-feasibility analysis system for hard rock mines
11	COALVAL, a lotus 1-2-3 based pre-feasibility analysis system for coal mines
12	PCMINSIM- a lotus 1-2-3 based system to evaluate the economics of a minerals operation.
13	PC/ADIT- a database containing identification information on major mineral properties evaluated by the USBM
14	CES, cost Estimation system
15	SURPAC 6.2
16	MATHCAD PRIME 1.0
17	MATLAB 2011
18	AUTOCAD 2011
19	Magenta Remark Office OMR6
20	Complete Microsoft Visual Studio 2010
21	ILWIS 3.6
22	ArcView 10
23	ERDAS 9.3
24	ARCGIS
25	SUFER 8
26	AQUACHEM
27	Rock Works
28	Geo-Chemist Work bench - GWB Standard 8.0 (Academics)

LIST OF BOOKS RECOMMENDED FOR THE PROGRAMME

S/No	Textbooks
1	Activated Carbon Adsorption, Bansal Chand Roop, Meenakshi Goyal, 2005
2	Advances in Gold Ore Processing, Adams M.D. 2005
3	Advances in Gold Ore Processing, Adams M.D. 2007, Elsevier
4	Advances in Gold Ore Processing, Volume 15 (Development in Mineral Processing) by M.S. Adams (Hardcover - Dec 13,2005)
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6	Alternate Energy, Winebrake J. James, 2004
7	Applied Clay Mineralogy, Volume 2: Occurrences, Processing and Applications of Kaolins, Bentonites, Palygorskitesepiolite, and Common Clays (Developments in Clay Science) by Haydn H. Murray (Hardcover - Feb 21, 2007)
8	Applied Clay Mineralogy,Murray H.H. 2007, Blackwell Science Ltd.
9	Applied Mineral Inventory Estimation by Alastair J. Sinclair and Garston H. Blackwell (Hardcover - April 2002)
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11	Applied Stratigraphy, Koutsoukos A.M. Eduardo, 2007, Elsevier
12	Applied Subsurface Geological Mapping with Structural Methods, Tearpock J. Daniels; Bischike E.Richard, 200 Oxford Universiy Pess
13	Applied Subsurface Geological Mapping, Walker G. Laurence, 2003, Bernard Goodwin
14	Approaches to Handiling Environmental Problems in the Mining and Metallurgical Regions (NATO Science Series: IV: Earth and Environmental Sciences) by Walter Leal Filho and Irina Butorina (Paperback - Feb 22, 2009)
15	Archae-mineralogy, Rapp (RIP) George 2002 Satish Kumar Jain
16	Basic Linear Geostatistics, Armstrong Margaret, 2003, Blackwell
17	Bicontinuous Liquid Crystals, Lynch L. Mathew & Spicert Patrick, 2005, Taylor & Francis
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19	Biogeochemistry in Mineral Exploration, Dunn E. Colin, 2004, Elsevier
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21	Biogeochemistry of Trace Elements in Coal and Coal Combustion Byproducts, Sajwan S.kenneth;A Lva K.Ashok,et al,20001 CRC Press
22	Borehole Flow Modelling in Horizontal, Deviated and Vertical Wells, Chin C. Wilson, 2003, CRC Press
23	Coal and Coal-Related Compounds, Kabe, T, Ishihara, A. et al, 2005, Brandona Nordin
24	Coal Geology by Larry Thomas; ISBN: 978-0-471-48531-5 Hadcover 396 pages, August 2002
25	Coal Geology, Thomas Larry 2003 Blacwell Science Ltd.
26	Colloid and Surface Properties of Clays and Related Minerals, Giese F. Rossman; Oss Van J. Carel, 2004, Oxford University Press
27	Deep Geological Disposal of Radioactive Waste, Alexander W.R.L Mckinley L.E., 2000, Shri D. Chakraborn
28	Deposit and Geonvironmental Models for Resources Exploitation and Environmental Security, Fabbri, G. Andrea; Gaal Gabor,et al
29	DESIGN ANALYSIS IN ROCK MECHANICS, London, 2007, Pb, 560 Pages, Pariseau, W.G. /
30	DESIGN ANALYSIS IN ROCK MECHANICS, LONDON, 2007, Pb,560 Pages, [Chapters Include Introduction, Slope Stability; Shafts; Tunnels; Entities in Statified Ground; Three-Dimensional Excavations; Subsidence; Appendix; Background; Literature; Appendix - Machanical Properties Of Intact Rock And Joints; Appendix - Rock Mass Classification Schemes For Engineering; Appendix - Some Useful Formulas] Pariseau, W.G /
31	Dictionary of Geology & Mineralogy, McGraw-Hill, 2003
32	Driling Fluids Processing Handbook by ASME Shale Shaker Committee (Hardcover - Dec 3, 2004)
33	Effective Oracle Database 10g SE, Knox C. David, Brandona Nordin
34	Electric Energy Sharkawi El A. Mohammed, 2005, CRC Press
35	Elemental Geosystems, Christopherson W. Robert, 2004 Pearson
36	Engineering Geology for Infrastructure Planning in Europe, Hack Robert, Azzam Rafig, et al, 2007, University of New South Wales Press Ltd.

37	Engineering Geology for Underground Rocks Peng Suping,Jincai Zhang,2005 McgRAW-hILL
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44	Formulas and Calculations for Drilling, Production and Workover, Lapeyrouse J. Norton, 2002, Elsevier
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47	Fundamentals of Reservoir Engineering, Dake L.P. 2005, Elsevier
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49	Gas Well Testing Handbook, Chaundhry Amanatu, 2007, Pennwell Corporation
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104	Uranium Resources Processing by Chiranjib Gupta and Harvinderpal Singh (Hardcover - Feb 12, 2003) by Linda Starke (Haredcover - Feb 2033)
105	Wills' Mineral Processing Technology, Seventh Edition: An Introduction to the Practical Aspects of Ore Treatment and Mineral Recovery by Tim Napier-Munn and Barry A. Wills (paperback - Oct 27, 2006)
106	Wills' Mineral Processing Technology, Wills B.A. Munn-Napiertj, 2006, Elsevier
107	Wills Minerals processing Technology Willis B.A.; Munn Napier-T.J., 2001 ELSEVIER
108	Advances in Gravity Concentration; Editors: R.W. Honaker, W. R. Forrest, Published by Society for Mining, Metallurgy, and Exploration, 2003, 196 pages (ISBN: 978-0-87335-227-7)
109	Basics of Metal Mining Influenced Water Editor: Virginia T. McLemore; Published by Society for Mining, Metallurgy, and Exploration - 2008, 104 pages
110	Beneficiation of Phosphates, Edited by Zhang, Swager, Filho, El-Shall; Published by Society for Mining, Metallurgy, and Exploration, 2009, 396 pages
111	Chemistry of Gold Extraction, Second Edition; Authors: John O. Marsden, C. Iain House, Published by Society for Mining, Metallurgy, and Exploration, 2006, 680 pages
112	Circulating Load: Practical Mineral Processing Plant Design: Author: Robert Shoemaker; Published by Society for Mining, Metallurgy and Exploration, 2002, 56 pages
113	Copper Leaching, Solvent Extraction, and Electrowinning Tech. Editor: Gerald V. Jergensen II, Published by Society for Mining, Metallurgy and Exploration, 1999, 305 pages
114	Designing the Coal Preparation Plant of the Future; Arnold J. Barbara; Klima S. Mark, et al, 2004, Bernard Goodwin
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116	Diamond Deposits: Origin, Exploration & History of Discovery; Authors: Edward II. Herlich, W. Dan Hausel; Published by Society for Mining, Metallurgy, and Exploration, 2002, 392 pages
117	Equipment Management; Author: Paul D. Tomlingson Published by Society for Mining, Metallurgy, and Exploration, 2009; 324 pages

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119	Froth Flotation: A Century of Innovation: Editors: Maurice C. Luerstenau, Graeme Jameson, Roe-Hoan Yoon, Published by Society for Mining, Metallurgy, and Exploration, 2000, 904 pages
120	Fundamentals of Aqueous Metallurgy: Author: Kenneth N. Han; Published by Society for Mining, Metallurgy, and Exploration, 2002, 212 pages
121	Fundamentals of Aqueous Metallurgy: Author: Kenneth N. Han; Published by Society for Mining, Metallurgy, and Exploration, 2002, 212 pages
122	Georgia Kaolins: Geology and Utilization; Authors: Jessica Elzea Kogel et al; Published by Society for Mining, Metallurgy, and Exploration, 2002, 96 pages
123	History of Grinding; Authors: Alban J. Lynch, Chester A. Rowland, Published by Society for Mining, Metallurgy, and Exploration, 2005, 216 pages;
124	Hydrometallurgy 2008: Proceedings of the 6th Intl Symposium; Editors: Courtesy A. Young, Patrick R. Taylor, Corby G. Anderson, Published by Society for Mining, Metallurgy, and Exploration, 2008, 1,200 pages
125	Industrial Minerals & Rocks, Seventh Edition: Editors: Jessica Elzea Kogel, Nikhil C. Trivedi, James M. Barker, Stanley T. Krukowski; Published by Society for Mining, Metallurgy, and Exploration, 2006 1568 pages
126	Introduction to Cut-Off Grade Estimation, Author: J.M. Rendu; Published by Society for Mining, Metallurgy, and Exploration, 2008, 112 pages
127	Management of Mineral Resources: Author: Juan P. Camus; Published by Society for Mining, Metallurgy, and Exploration, 2002, 120 pages
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129	Mine Health and Safety Management; Author: Michael Karmis, Published by Society for Mining, Metallurgy and Exploration, 2001, 472 pages
130	Mine Health and Safety Management; Karmis Michael, 2005, CRC Press
131	Mine Maintenance Management Reader: Author: Paul D. Tomlingson, Published by Society for Mining, Metallurgy and Exploration, 2007, 96 pages
132	Mine Pit Lakes: Edited by Devin N. Castendyk and L. Edmond Eary, Published by Society for Mining, Metallurgy, and Exploration, 2009, 312 pages
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134	Mining Engineering Analysis, Second Edition; Author: Christopher J. Bise; Published by Society for Mining, Metallurgy, and Exploration, 2003, 328 pages
135	Mitigation of Metal Mining Influenced Water; Editors: James J. Gusek and Linda A. Figueroa, Published by Society for Mining, Metallurgy, and Exploration, 2009, 172 pages,
136	North American Tunneling 2008 Proceedings: Editors: Michael F. Roach, Marc R. Kritzer, Dennie Ofiara, Bradford F. Townsend; Published by Society for Mining, Metallurgy, and Exploration, 2008, 896 pages
137	Politics of Mining: What They Don't Teach You in School by Deepak Malhotra (Paperback - Jan 2001)
138	Politics of Mining: What They Don't Teach You in School: Editor: Deepak Malhotra Published by Society for Mining, Metallurgy, and Exploration, 2001, 164 pages
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140	Principles of Mineral Processings: Editors: Maurice C. Fuerstenau, Kenneth N. Han; Published by Society for Mining, Metallurgy, and Exploration, 2003, 584 pages
141	Rapid Excavation & Tunnelling Conference Proceedings 2009: Editors: Editors: Gary Almeraris, Bill Mariucci; Published by Society for Mining, Metallurgy, and Exploration, 2009, 1400 pages:
142	Recent Advances in Mineral Processing Plant Design; Editors: Deepak Malhotra, Patrick, Taylor, Erik Spiller, and Marc LeVier, Published by Society for Mining Metallurgy, and Exploration, 2009, 592 pages
143	Recommended Contract Practices for Underground Construction: Editor: William Edgerton; Published by Society for Mining, Metallurgy, and Exploration, 2008, 156 pages
144	Rock Slope Stability; Author: Charles Kliche, Published by Society for Mining, Metallurgy, and Exploration, 1999, 272 pages
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300	Interpretation and Regression Analysis for Chemical Engineers,
301	Problem Solving in Chemical and Biochemical Engineering with Polymath, Excel and Matlab, Michael B. Cutlip& Moedechai Shacham
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303	Numerical Methods using Mathcad, Laurene Fausett
304	Analysis, Synthesis and Design of Chemical Processes, Richard Turton
305	Multiphysics Modeling using COMSOL 4, Roger Pryor
306	Plantwide Dynamic Simulators in Chemical Processing anbd Controls, William Luyben
307	Response Surface Methodology, Douglas C. Montgomery
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Minimum Physical Facilities Required for
National Diploma Mineral and Petroleum Resources Engineering Technology

LABORATORIES	WORKSHOPS	DRAWING STUDIO
i. Mineral Analysis ii. Fluid Mechanics/Hydraulics iii. Geology and Geophysical iv. Mining v. Mineral Processing vi. Thermodynamics/Heat Engine vii. Petroleum Laboratory	i. Mechanical ii. Electrical iii. Surveying and Photogrammetry equipment store	i. Engineering Drawing ii. Cartography

Mineral Analysis Laboratory

S/No.	Description	Qty
1.	Weighing bottles with lid. 30 x 30mm	10
2.	Analytical quick-acting filter funnel, (diameter 70mm)	10
3.	Separating funnel 250ml	5
4.	Suction flask (250ml)	2
5.	Holder for burettes (single type)	10
6.	Test tubes	50
7.	Holder for test tubes	20
8.	Stand for pipettes and test tubes	5
9.	Manual cork borer	2
10.	Gas burners	5
11.	Filter paper (normal, high density, mean density, low density)	5 pkts
12.	Laboratory spoon	5
13.	Platinum crucible (diameter 30mm), stirrer, dish and wire net	5 each
14.	Porcelain grinding mortar with pestle	5
15.	Porcelain crucible (diameter 30mm, 100mm)	10
16.	Porcelain evaporating dish (diameter 75mm, 100mm	10 each
17.	Erlenmeyer flask (300ml)	4
18.	Cooler (Leibig type)	4
19.	Instrument Cabinet (1200 x 600 x 180mm)	2
20.	Laboratory work bench	10
21.	Fume Chamber	1
22.	Cabinets for chemical compounds	2
23.	Tubular furnace	2
24.	Heating Coil	5
25.	Spatulas	20
26.	Reagent for element analysis (eg. For EDTA, compplexometric titrations, etc.	Assorted
27.	Electrolytic cell	3
28.	Calomel Reference electrode	2
29.	Vacuum drying oven (max temp 200 C)	1
30.	Hydrogen electrode	2
31.	Heat of combustion apparatus	1
32.	Isothermal Calorimeter complete with immersion heater and stopper	2
33.	Bomb Calorimeter	1
34.	Water deionizer (15 litre/hr)	2
35.	Analytical balance	2
36.	Bunsen Burners	10
37.	Titrimetric flasks (250ml)	10
38.	Narrow necked conical flask (50ml, 1000ml)	5 each
39.	Burettes with stop lock (50ml, 10ml)	5 each

40.	Pipette with one mark (5ml, 10ml, 50ml)	5 each
41.	Graduated pipette and Cylinder (10ml, 25ml)	5 each

Fluid Mechanics/Hydraulics Laboratory

S/No	Description	Quantity
1	Turbine Set (pelton Francis Pump, or Kaplan)	1
2	Hydraulics Bench with accessories for various experiments in fluid	2
3	flow measurements	1
4	Weir Tank	1
5	Friction loss in pipes apparatus.	1
6	Bernoulli apparatus	2
7	Floating body apparatus	1
8	Losses in fitting and pipe bending apparatus Universal pump testing unit	1
9	Centrifugal pump set	1
10	Reciprocating pump set	1
11	Manometer	1
12	Rotameter	1
13	Laminar flow apparatus	1
14	Pilot static tube	1
15	Free and force vortices apparatus Parallel-series centrifugal pump set Universal radial flow apparatus	1
	Water Meter	2
17	Hot wire anemometer	2
18	Pelton wheel apparatus	1

Geology & Geophysical Laboratory

S/No	Description	Quantity
1	Ore Microscopes	2
2	Lens of various magnification (xl0, x100, 1500) Petrological Microscope	5 each
3	Stereo microscope '	5
4	Rock grinding and polishing machine	1
5	Thin Sectioning Unit	3
6	Mineral and Rock Samples	1
7	Geological Hammers	5 of each
8	Atomic Absorption Spectrometer'	10
9	Geological Models	1
10	Mechanical sieve	Assorted
11	Sediment meter for particle size analysis	2
12	PH meter	1
13	Conducting meter	1
14	Water - level indicators	1
15	Laboratory work benches	5

16	Air Conditioner for the laboratory	1
	For HND Only	
1	Magnetometer	3
2	Gravimeter	3
3	Terrameter	3
4	Seismic equipment (Seismograph)	2

Mining Laboratory

S/No	Description	Quantity
1	Suction Pump	12
2	Axial flow pumps	12
3	Submersible pumps	12
4	Centrifugal pumps	4
5	Drill bits (chisel, cross, X-bit, button, reto, rolling cutter)	4 each
6	ex: Mine ventilation analogue	1
7	Anemometer	1
8	Water guage	4
9	Manometer	2
10	Hygrometer	3
11	Fan Test Set	4
12	Mine models	4
13	Velometer	4
14	Kinanometer (quantity) sampler	2
15	Decimeter (Noise level meter)	2
16	Gravimetric dust sampler	2

Mineral Processing Laboratory

S/No.	Description	Qty
1.	Jaw Crusher	1
2.	Ball – Mill	1
3.	Wet and dry grinding mills	1 each
4.	Separators (gravity, magnetic, electrostatic)	1 each
5.	Dry and wet sieves	2 each
6.	Sample reducer	1
7.	Sample splitter	1
8.	Gyratory crusher	1
9.	Cyclone	1
10.	Drying Ovens	2
11.	Analytical balances	2
12.	Scales	4

13.	Sample Containers	5
14.	Froth flotation cell	2
15.	Tanks for solutions with stirrers	5
16.	Thermometric titrator	2
17.	Potentiometric titrator	2
18.	Solvent extraction Apparatus	2
19.	Laboratory – Size Rotary furnace (Electric type)	1

Thermodynamics/Heat Engines Laboratory

S/No.	Description	Quantity
1	Water-Heater/Stirrer unit with bath	1
2	Un-calibrated mercury in glass thermometer 10 to 100 C	25
3	Resistance Thermometer	1
4	Bench mounted air-rolled 4 stroke diesel engine rig including dynamometer	1
5	Bench mounted air-cooled 2 stroke petrol engine rig including dynamometer	1
6	Auto bomb calorimeter	1
7	Boyle gas calorimeter	1
8	Orsal gas analyzer	2
9	Tachometer	1
10	Stroboscope	1
11	Air compressor test set	1
12	Thermal conductivity apparatus	1
13	Marcet boiler	1
14	Steam boiler plant	1
15	Mechanical equivalent of heat apparatus	1
16	High pressure vapour unit	1
17	Vapour density apparatus	1
18	Pressure Cooker	1
19	Stirling heat pump	1
20	Falling ball viscometer	1
21	Rotary viscometer	1
22	Gas laws apparatus	1
23	Two - Stage air compressor	1
24	Refrigeration demonstration unit	1
25	Air-conditioning laboratory unit	1
26	Speedomax Recorder	1
27	Thermal anemometer	1
28	Electric anemometer	1
29	Pyrometer, infrared, non-contact digital intra-trace	1
30	Combined separating and throttling calorimeter	1
31	Fire extinguishers .	1
32	Sand and water buckets	4
33	Air thermometer (Constant-Volume)	4

Petroleum Laboratory

S/No.	Description	Qty
1.	Mud Testing kit	1
2.	Mixer machine	1
3.	Mash funnels	5
4.	Mash cups	5
5.	Mud balance	2
6.	Centrifuge machine	1
7.	Measuring balance	2
8.	Hot plate	1
9.	Incubator	1
10.	Microscope	1
11.	Compression machine	1
12.	Oven	2
13.	Timer	2
14.	PH – Meters	2
15.	Fann Viscometers	2
16.	Manual Centrifuge	2
17.	Bunsen Burners	20
18.	Hydrometers	20
19.	Pipettes	30
20.	Thermometers	20
21.	Burettes	10
22.	Density Bottles	10
23.	Stop watches	10
24.	Measuring cylinders	30
25.	Flask	30
26.	Mud Tank	1
27.	Beaker	3-
28.	Reagent bottles	10

WORKSHOPS AND STUDIOS
Mechanical Workshop

S/No	Description	Quantity
1	**Drill Press**	
2	Pillar drilling machine	2
3	Bench drill machine with rotating table and steel base	2
4	**Accessories**	
5	(i) drill sets in boxes	4
6	29 drills 1/16"x 1/2"	4
7	19 drills 1mm	4
8	(ii) Cluck keys – spare	
	Shaping/Planning Machine	
1	1. Shaping machine	2
2	2. Planning machine	2
	Guillotines	
1	Kingland type AM 40 Complete with 1 pair standard blades, front airms, back gauge, side gauges, beam stop and guards.	1
2	Gabro type guillotine/Notches 4M	1
3	Gabro type box/pan folder BF 620	
4	Gabro type combined aperture guillotine and hole puncher AC 450	1
	Lathes	
1	Turret lathe or capstan lathe'	
2	Harrison trainer 250 - dual purpose CNC/manual lathe complete with bench, 9 speed head-stock Coolant, apron drive and CNC control	2
3	Bench lathe (Melcer -3) Model	1
	Riveter	2
1.	Riveting machine	1
	Saw	
1.	Power hacksaw (metal cutting machine) with accessories	1 unit
	Welding/Fabrication Equipment	
1	Electric Unit with accessories	2
2	Gas Unit with accessories	2
3	Welding neds	2
4	Brazing equipment	2
5	Brazing rods	2
6	Soldering rods	2
7	Safety goggles	2
	Pliers	
1	Engineers Combination 6"	6
2	Multi-groove 10"	6
3	Needle use 6"	6
4	Vice grip 10"	6

5	Slip joint 8"	6
6	Diagonal cutting 8"	6
7	Long nose 6"	6
8	Side cutting	6
5	**Punches**	
1	Centre punch 6"x 1/8"	5
2	Drift punch 16"	5
3	Drive pin punch	5
4	Starting punch	5
	Screw Driver	
1	Standard .tip l/4"x 4"	5
2	Standard tip 5/16"x 16"	5
3	Offset straight tip 1 and 2	5
4	Straight tip spring clip 1jz"x 6"	5
	Spanners	
1	BSW Spanner and Wrench	5
2	Open-ended Spanner Sets British Whitworth set Metric set	5
3	Ring Spanner sets:	5
4	Miniature Spanner sets:	5
5	Socket spanner set 1/2" drive	5
	Files	
1	Bastard 8" (flat, half round, square, round)	5
2	Cabinet 8" (flat smooth, 1/2 round smooth, 1/2 round second cut, round second cut).	5
3	Flat 8" (second cut, smooth)	5
4	Half round 8' (second cut, smooth) 5. Square 8" (second cut, smooth)	5
5	Handles size 2 to fit above	10
6	Needle file set	10
	Micrometers	
1.	Three sizes (capacities 0-1", 0-2", 0-3" outside set, inside set)	6
	Rules	
1	Flexible stainless steel l' rule graduated \n metric one side and 1/8, 1/16, 1/32 on reverse	10
2	Heavy duty punch/pull graduated metric/imperial 16ft with locking mechanism	10

Electrical Workshop (ND)

S/No	Description	Quantity
1	Electrical tool kits	4
2	Soldering Iron and Equipment	5
3	Avometers	5
4	Ammeters	5
5	Voltmeters	5
6	Wiring boards	5

7	Consumer Units:	assorted
	i.) Circuit breakers	5
	ii.) Distribution box	assorted
	iii.) Plugs, Switches,	1
8	Electrostatic test material kit	5
9	Condensers (Capacitors)	2
10	Electric field apparatus	4
11	Electroscope (Gold leaf) type	10
12	Rheostat 11.6 ohm, 4.0 amps.	5
13	Standard resistance	5
14	Resistance box 999.9 ohm x 0.1 ohm	5
15	Resistance unknown standard 4.5 ohm	15 each
16	Resistance known standard (1 ohm, 2 ohm, 5 ohm, 10 ohm)	5
17	Wheatstone bridge	5
18	Potentiometers	10
19	Resistance Coil	10
20	Jockeys	5
21	Galvanometers	5
22	Solenoids; (magnetizing, demagnetizing)	2
23	Induced current apparatus	2
24	Induction coil	2
25	Electromagnetic kit	2
26	Transformers	5
27	Oscilloscope	2
28	Electronic Experiment kit	2

Surveying and Photogrammetric Equipment Store

S/No.	Description	Qty
1.	Theodolites (including tripods)	
	(i) 4” Venier	1
	(ii) 10” Optical	3
	(iii) 1” Optical	2
	(iv) Gyrotheodolite	1
	(v) Compass theodolites	2
	(vi) Self reducing tacheometers	2
2.	Levels (including tripods)	2
	(i) Tilting	2
	(ii) Dumpy	2
	(iii) Self aligning	1
	(iv) Precise	2
	(v) Hand sighting	2

Miscellaneous		
3.	Sub-tence bars	5
4.	Theodolite illumination sets	10
5.	Clinometers	8
6.	Tapes/Chairs: 30m chain	6
	30m Steel band	6
	100m steel band	4
7.	Prismatic compass and tripods	5
8.	Plane table equipment	10
9.	Leveling staves	10
10.	Invar (geodetic staves)	4
11.	Chronometers and stop watches	5
12.	Programmable calculator/printers	3
13.	Seven figure tables	20
14.	Inclinometer or Abney levels	4
15.	Field books level	8
16.	Field survey boards and clips	8
17.	Planimeter	3
18.	Pantograph	1
19.	Stereoscopes	4
20.	Maps and Projections in for wall-charts	Assorted
21.	Thematic maps (eg. Isogonic, topographic, etc.)	Assorted

Cartographic Studio

S/No	**Description**	**Quantity**
1	Drawing Tables	30
2	Light tables	3
3	Co-ordinator graph	1
4	Diazo printer	1
5	Trimmer	1
6	Pantograph	5
7	Lettering sets	10
8	Letter pencil	5 sets
9	Proportional dividers	5
10	Map measures	5
11	Scribing tool sets	5
12	Rapidographs	2 sets
13	Straight edger	10
14	Triangular sealers	10
15	Drawing instrument set	5
16	Planimeters	10

	Drawing Studio (ND/HND)	
1	Blue Printing machine	1
2	Drawing table complete with drafting machine	30
3	Drawing table complete with pens for ink work	30
4	55 set squares	30
5	60 set squares	50
6	Adjustable set squares	30
7	Desk sharpener	4
8	Scale rule (triangular and flat)	30 each
9	Black Board rule	4
10	Black - Board Tee - Square	4
11	Black board set squares (45 & 60)	4 each
12	Black board compasses	4
13	Black board protractor	4
14	French Curve	24
15	Letter and number stencils 2mm, 4mm, 5mm, 7mm, 8mm and 1Omm	10 each

Safety Equipment for each Laboratory

S/No.	**Description**	**Qty**
1	First Aid Box	1
2	Fire Extinguisher	3
3	Sand buckets	3
4	Safety charts and drawing	assorted

Safety Equipment for each Workshop

S/No.	**Description**	**Qty**
1	First Aid Box	1
2	Safety goggles	20
3	Safety helmets	20
4	Safety boots	20 pairs
5	Leather Apron	20
6	Leather hand gloves	20 pairs
7	Fire Extinguisher	3
8	Sand buckets	3
9	Safety charts and drawing	assorted

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