NATIONAL BOARD FOR TECHNICAL EDUCATION

PLOT ‘B’ BIDA ROAD, P. M. B.2239, KADUNA

CURRICULUM AND COURSE SPECIFICATION

FOR

HIGHER NATIONAL DIPLOMA IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY

OPTIONS IN:

i. PETROCHEMICAL AND GAS PROCESSING ENGINEERING TECHNOLOGY
ii. PETROCHEMICAL AND POLYMER ENGINEERING TECHNOLOGY
iii. GAS PROCESSING ENGINEERING TECHNOLOGY
iv. PETROLEUM REFINING ENGINEERING TECHNOLOGY

APRIL, 2022

FOREWORD

The Higher National Diploma (HND) in Petroleum and Gas Processing Engineering Technology with Option in Petrochemical and Gas Processing, Petrochemical and Polymer, Gas Processing and Petroleum Refining curriculum is designed to be used by training institutions to produce manpower for industries nationwide.

The acute shortage of professionally trained petroleum and gas processing engineers in these industries in Nigeria as well as the need to produce professional practitioners with good ethics and career progression, through the acquisition of desirable knowledge and skills necessitated the production of this curriculum.

It is my belief that this curriculum and course specifications which is the minimum required to produce technicians with sound knowledge and skills Petroleum and Gas Processing Engineering Technology. If properly implemented with the required resources (qualified teaching staff in adequate number and mix, adequate consumables, training materials, teaching aids) and qualified candidates are admitted into the programme, will lead to the production of competent and skilled technicians required in the sector.

I wish to express my deep appreciation to Petroleum Training Institute Warri for collaborating with the Board and funding the development of this curriculum. The invaluable contributions of all the members of the committee for the development of the curriculum are appreciated.

I hope that the curriculum would be properly implemented, so as to produce the required Work Force of our dream.

Prof. Idris M. Bugaje

Executive Secretary

NBTE, Kaduna

GENERAL INFORMATION

1.0 TITLE OF THE PROGRAMME: The title of the programme is Higher National Diploma in Petroleum and Gas Processing Engineering Technology.

2.0 PHILOSOPHY OF THE HND PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY PROGRAMME

The Petroleum and Gas Processing Engineering Programme is designed to reflect a **FUNCTIONAL** philosophy of education. While seeking to achieve academic excellence and promote the furtherance of knowledge, the Petroleum and Gas Processing Engineering also seeks to aid "the acquisition of appropriate skills, abilities and competence, both mental and physical as to equip the individual to live in and contribute to the development of his/her society".

The programme is therefore committed to the production of qualified and competent technologists who will be able to face the challenges concomitant with the aspiration of the country to be technologically developed.

3.0 Goals and Objectives of the Programme

3.1 Goal:

The Higher National Diploma (HND) programme in Petroleum and Gas Processing Engineering Technology with options in Petrochemical and Gas Processing, Petrochemical and Polymer, Gas Processing and Petroleum Refining is designed to produce Technologists who will be equipped with techniques and processes that shall serve the both the Upstream, Midstream and Downstream sector of the petroleum industry.

3.2 Objectives:

A. On completion of Higher National Diploma (HND) in Petrochemical and Gas Processing Engineering Technology, the Diplomats shall be able to:

1. Develop process and equipment for petrochemicals and gas operations
2. Select suitable process and equipment to accomplish petrochemicals and gas operations
3. Participate in production operations and upgrade of petrochemicals and gas operations systems
4. Carry out petroleum refining operations and catalyst development.
5. Carry out routine inspection of petrochemical and gas process equipment.
6. Carry out maintenance and repairs of petrochemical and gas process equipment
7. Use Computing Systems in design and application of basic petrochemicals and gas operations.

8. Apply safety measures in petrochemicals and related industries.
9. Undertake direct or supportive role in academic research and training.
10. Use effective communication skills to manage enterprise

B. On completion of Higher National Diploma (HND) in Petrochemical and Polymer Engineering Technology, the Diplomats shall be able to:

1. Develop process and equipment for Petrochemicals and Polymer operations.
2. Select suitable process and equipment to accomplish petrochemicals and Polymer operations
3. Participate in production operations and upgrade of petrochemicals and Polymer operations systems
4. Carry out petrochemical and Polymer Production, Refining operations and catalyst development.
5. Carry out routine inspection of petrochemical and Polymer process equipment.
6. Carry out maintenance and repairs of petrochemical and Polymer process equipment
7. Use Computing Systems in design and application of basic petrochemicals and Polymer operations.
8. Apply safety measures in petrochemicals and Polymer production and related industries.
9. Undertake direct or supportive role in academic research and training.
10. Use effective communication skills to manage enterprise

C. On completion of Higher National Diploma (HND) in Gas Processing Engineering Technology, the Diplomats shall be able to:

1. Develop process and equipment for gas operations.
2. Select suitable process and equipment to accomplish gas operations
3. Participate in production operations and upgrade of gas operations systems
4. Carry out petroleum refining operations, Gas processing and catalyst development.
5. Carry out routine inspection of gas processing equipment.
6. Carry out maintenance and repairs of gas processing equipment
7. Use Computing Systems in design and application of basic gas operations.
8. Apply safety measures in Gas processing and related industries.
9. Undertake direct or supportive role in academic research and training.
10. Use effective communication skills to manage enterprise

D. On completion of Higher National Diploma (HND) in Petroleum Refining Engineering Technology, the Diplomats shall be able to:

1. Develop process and equipment for Petroleum Refining.

2. Select suitable process and equipment to accomplish Petroleum Refining
3. Participate in production operations and upgrade of Petroleum Refining systems
4. Carry out petroleum refining operations and catalyst development.
5. Carry out routine inspection of Petroleum Refining equipment.
6. Carry out maintenance and repairs of Petroleum Refining equipment
7. Use Computing Systems in design and application of basic Petroleum Refining operations.
8. Apply safety measures in Petroleum Refining and related industries.
9. Undertake direct or supportive role in academic research and training.
10. Use effective communication skills to manage enterprise.

4.0 ENTRY REQUIREMENTS

4.1 Higher National Diploma

The general entry requirements for the HND programme include:

a) All the requirements for admission into ND programme in Petroleum and Gas Processing Engineering Technology and Chemical Engineering Technology from a recognized institution.
b) A minimum of lower credit (CGPA) of 2.50 and above in ND in Petroleum and Gas Processing Engineering Technology with one year post ND industrial experience.
c) In exceptional cases, diplomats with a pass grade (CGPA) 2.0 - 2.49 in the ND with minimum of two years post ND industrial experience may be admitted into the HND programme. However, the number of these candidates should not be more than 10% of the total student intake in each class.
d) A minimum of lower credit (CGPA) of 2.50 and above in ND Chemical Engineering Technology or ND in Petroleum Engineering. In exceptional cases, diplomats with a pass grade (CGPA) 2.0 - 2.49 in ND Chemical Engineering Technology and ND Petroleum Engineering with minimum of one year post ND industrial experience may be admitted into the relevant HND programme.

5.0 MAN POWER REQUIREMENT:

5.1.1 HEADSHIP OF THE DEPARTMENT

The HOD should at least be a Senior Lecturer with relevant specialization in any of the following areas: Chemical Engineering, Petrochemical and Gas Processing Engineering, Petroleum and Gas Processing Engineering, Petroleum Engineering or Process Engineering.

The HOD must also be a duly registered member of COREN or COMEG.

5.1.2 The first appointment of the core teaching staff for HND Petroleum and Gas Processing Engineering Technology should be an Assistant Lecturer with a first degree (BSc. BTech or HND+PGD) in any of the engineering courses listed in 5.1.1 above. The Instructor should have HND (Lower Credit) in any of these courses listed in 5.1.1.

5.1.3 Technical Staff

5.1.3.1 Technologist
Technologists should have an HND (Lower Credit) in any of the disciplines as stated in 5.1.1 above.

5.1.3.2 Technician
Technicians should have ND (Lower Credit) as stated in 5.1.1 above.

5.2 Criteria for appointment of HND External examiners

5.2.1. An External Examiner shall be appointed among Academic Staff from other Institutions with specialization in any of the

Following areas: Chemical Engineering, Petroleum and Gas Processing Engineering, Petrochemical Engineering, Gas Processing Engineering, Petroleum Engineering or Process Engineering

5.2.2 Two External Examiners shall be appointed; one from the academia not below the rank of a Principal Lecturer or its equivalent and one from the Industry.

5.2.3 The External Examiner shall serve for a term of two years in the first instance and renewable for one more term only.

5.3 AREAS IN WHICH HND PETROLEUM AND GAS PROCESSING ENGINEERING TECHNNOLOGY HOLDERS CAN GET EMPLOYMENT (CARRIER PROSPECTS).

Successful graduates of the HND Petroleum and Gas Processing Engineering Technology can proceed further to Postgraduate Studies. An HND graduate may seek job from the following:

i) Refinery
ii) Petrochemicals.
iii) Oil and Gas Fields
iv) Power Plant
v) Ministry of Petroleum Resources at Federal level
vi) Fertilizer Plant
vii) Gas Processing Industries

viii) Polymer industries
ix) Public sector at Federal and State levels, etc.

6.0 DURATION

The Higher National Diploma in Petroleum and Gas Processing Engineering Technology Programme is a terminal one, and is structured to last for a minimum of two academic sessions (4 semesters) and a maximum of four academic sessions (8 semesters).

7.0 CURRICULUM

7.1 The curriculum of HND programme consists of four main components. These are:

a. General studies/education
b. Foundation courses.
c. Professional courses
d. Student Industrial Work Experience Scheme (SIWES)

7.2 The General Education component shall include courses in:

The General studies components shall include courses in: Art and Humanities- English Language and Communication Social Studies – Citizenship Education, and Entrepreneurship are compulsory. The General Education component shall account for not more than 15% of the total contact hours for the programme.

Foundation courses include courses in Mathematics, Pure Science, Technical Drawing, and Statistics, etc. The number of hours for the programme may account for about 10-15% of the total contact hours.

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 technical/technologist level. These may account for between 60-70% of the contact hours.

8.0 CURRICULUM STRUCTURE

The structure of the HIGHER NATIONAL DIPLOMA programme consists of four semester of classroom, laboratory and workshop activities in the college. Each semester shall be of 17 weeks duration made up as follows:

a. 15 weeks of teaching, i.e. recitation, practical exercise, quizzes, test, etc; and
b. 2 weeks for examinations and registration.

9.0 ACCREDITATION

The programme shall be accredited by the National Board for Technical Education before the diplomates can be awarded the Higher National Diploma certificates. Details about the process of accrediting a programme for the award of the Higher National Diploma are available from the Executive Secretary, National Board for Technical Education, Plot “B”, Bida Road, P.M.B. 2239, Kaduna, Nigeria. Website: ***www.nbte.edu.gov.ng***

10.0 AWARD OF HIGHER NATIONAL DIPLOMA

Conditions for the award of HIGHER NATIONAL DIPLOMA include the following:

a. Satisfactory performance in all prescribed course work which may include class work, tests, quizzes.
b. Workshop practice, laboratory work.
c. Satisfactory performance at all semester examinations.
d. Satisfactory completion of final year project work. Normally, continuous assessment contributes 30%, project work 10% while semester examinations are weighted 60% to make a total of 100%.

10.1 Unified Grading System

The unified grading system to be applied in scoring all course work, examinations, project, etc is as stated in table below:

MARKED RANGE	LETTER GRADE	WEIGHTING
75% and above	A	4.00
70% – 74%	AB	3.50
65% – 69%	B	3.25
60% – 64%	BC	3.00
55% – 59%	C	2.75
50% – 54%	CD	2.50
45% – 49%	D	2.25
40% – 44%	E	2.00
Below 40%	F	0.0

10.2 Classification of Higher National Diploma

The final Cumulative Grade Point Average (CGPA) shall be determined (calculated) and applied to the classification of the Higher National Diploma as follows:

Class (Level of Pass)	**CGPA**
Distinction	3.50 and Above
Upper Credit	3.00 – 3.49
Lower Credit	2.50 – 2.99
Pass	2.00 – 2.49
Fail	Below 2.00

11.0 GUIDANCE NOTES FOR TEACHERS

11.1 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 wish to transfer the units already completed in an institution similar standard from which he/she is transferring.

11.2 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.

11.3 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 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 he 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.

11.4 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.

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 should be reported individually. The project should, as much as possible incorporates basic element 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.

13.0 GUIDELINES FOR TEXT BOOK WRITERS

NATIONAL DIPLOMA AND HIGHER NATIONAL DIPLOMA

The following guidelines are suggestions from the Science and Technology 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 use 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 Nigeria members of the curriculum working groups for their comments regarding the content in relation to the desired syllabus.

CURRICULUM TABLE

HIGHER NATIONAL DIPLOMA IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY

OPTIONS IN:

a) **PETROCHEMICAL AND GAS PROCESSING**

b) **PETROCHEMICAL AND POLYMER**

c) **GAS PROCESSING**

d) **PETROLEUM REFINING**

Year I: Semester I

Course Code	Course Title	L	P	CU	CH	PQT
GNS 301	Use of English III	2	-	2	2	-
CHE 301	Engineer in the Society	2	-	2	2	-
CHE 309	Chemical Thermodynamics II	2	1	2	3	-
CHE 312	Strength of Materials	2	1	2	3	-
PGP 311	Engineering Mathematics I	2	-	2	2	-
PGP 312	Advanced Petroleum and Gas Production Technology	2	-	2	2	-
PGP 313	Separation Process I	2	-	2	2	-
PGP 314	Chemical Process Laboratory Technique	-	2	2	2	-
PGP 315	Advanced Transport Phenomena I	2	-	2	2	-
PGP 316	Corrosion Control	2	1	3	3	-
PGP 317	Catalysis of Petrochemical Processes	2	-	2	2	-
	TOTAL	**20**	**5**	**23**	**25**	**-**
Gas Processing Option						
PPT 311	Advanced Petrochemical Process Chemistry	2	-	2	2	-
	TOTAL	**22**	**5**	**25**	**27**	**-**
Petrochemical and Gas option						
PPT 311	Advanced Petrochemical Process Chemistry	2	-	2	2	-
	TOTAL	**22**	**5**	**25**	**27**	**-**
Petrochemical and Polymer Option						
PPT 311	Advanced Petrochemical Process Chemistry	2	-	2	2	-
	TOTAL	**22**	**5**	**25**	**27**	**-**
Petroleum Refining Option						
PRT 311	Advanced Petroleum Chemistry	2	-	2	2	-
	TOTAL	**22**	**5**	**25**	**27**	**-**

Year I: Semester II

Course Code	Course Title	L	P	CU	CH	PQT
GNS 302	Communication in English II	2	-	2	2	-
CHE 306	Chemical Reaction Engineering II	2	-	2	2	-
PGP 321	Engineering Mathematics II	2	-	2	2	-
PGP 322	Computer Application in Process Engineering	2	1	2	3	-
PGP 323	Separation Process II	2	-	2	2	-
PGP 324	Petroleum Refining Processes I	2	-	2	2	-
PGP 325	Advanced Transport Phenomena II	2	-	2	2	-
PGP 326	Advanced Petrochemical Process Technology I	2	-	2	2	-
PGP 327	Advanced Polymer Science and Technology	2	-	2	2	-
	SUB-TOTAL	**18**	**1**	**18**	**19**	**-**
Gas Processing Option						
GPT 321	Gas Processing Laboratory Techniques I	-	3	2	3	-
GPT 322	Gas Production Technology I	1	3	2	4	-
	TOTAL	**19**	**7**	**22**	**26**	-
Petrochemical and Gas option						
PPT 321	Petrochemical Synthesis Laboratory Techniques	-	2	2	2	-
	TOTAL	**18**	**3**	**20**	**21**	**-**
Petrochemical and Polymer Option						
PPT 321	Petrochemical Synthesis Laboratory Techniques	-	2	2	2	-
	TOTAL	**18**	**3**	**20**	**21**	
Petroleum Refining Option						
PPT 321	Petrochemical Synthesis Laboratory Techniques	-	2	2	2	-
	TOTAL	**18**	**3**	**20**	**21**	**-**

Year II: Semester I

Course Code	Course Title	L	P	CU	CH	PQT
EEC 304	Instrumentation and Control	2	3	3	5	-
WEC 314	Introduction to Offshore Technology	**2**	**-**	**2**	**2**	**-**
CHE 403	Chemical Plant Economics	2	-	2	2	-
CHE 415	Engineering Management	2	-	2	2	-
PGP 411	Advanced Gas Processing Technology I	2	-	2	2	-
PGP 412	Separation Process III	2	-	2	2	-
PGP 414	Process Equipment Fabrication II	1	2	2	3	-
PGP 415	Gas Processing Laboratory Techniques II	-	3	2	3	-
PGP 416	Advanced Technical Report writing	1	-	1	1	-
	SUB-TOTAL	**14**	**8**	**18**	**22**	-
Gas Processing Option						
PPT 411	Fertilizer Technology	2	-	2	2	-
GPT 411	Natural Gas Thermodynamics	2	-	2	2	-
GPT 412	Liquefied Natural Gas (LNG) Technology	2	-	2	2	-
GPT 400	Final Year Project	-	-	-	-	-
	TOTAL	**20**	**8**	**24**	**28**	-
Petrochemical and Gas option						
PPT 412	Advanced Petrochemical Process Technology II	2	-	2	2	-
PRT 411	Petroleum Refining Processes II	2	-	2	2	-
PGP 400	Final Year Project	-	-	-	-	-
	TOTAL	**18**	**8**	**22**	**26**	**-**
Petrochemical and Polymer Option						
PPT 412	Advanced Petrochemical Process Technology II	2	-	2	2	-
PRT 411	Petroleum Refining Processes II	2	-	2	2	-
PPT 411	Fertilizer Technology	2	-	2	2	-
PPT 400	Final Year Project	-	-	-	-	-
	TOTAL	**20**	**8**	**24**	**28**	**-**
Petroleum Refining Option						
PRT 411	Petroleum Refining Processes II	2	-	2	2	-
PRT 400	Final Year Project	-	-	-	-	-
	TOTAL	**16**	**8**	**20**	**24**	**-**

Year II: Semester II

Course Code	Course Title	L	P	CU	CH	PQT
CHE 412	Plant Service and Maintenance	2	-	2	2	-
CHE 424	Process Dynamics and Control	2	-	2	2	-
EED 425	Entrepreneurship Development	2	-	4	4	-
PGP 421	Process Safety and Environmental Control	2	-	2	2	-
PGP 422	Process Integration and Optimization	2	-	2	2	-
PGP 423	Process and Equipment Design	2	-	2	2	-
PGP 424	Power Plant and Energy Integration	2	-	2	2	-
	SUB-TOTAL	**14**	**-**	**16**	**16**	**-**
Gas Processing Option						
GPT 421	Advanced Gas Processing Technology II	2	-	2	2	-
GPT 422	Gas Transmission and Distribution Network	2	-	2	2	-
GPT 423	Pipeline Engineering	2	2	2	4	-
GPT 400	Final Year Project	-	-	6	-	
	TOTAL	**20**	**2**	**28**	**24**	**-**
Petrochemical and Gas option						
GPT 421	Advanced Gas Processing Technology II	2	-	2	2	-
GPT 422	Gas Transmission and Distribution Network	2	-	2	2	-
PGP 400	Final Year Project	-	-	6	-	-
	TOTAL	**18**	**-**	**26**	**22**	**-**
Petrochemical and Polymer Option						
PPT 421	Advanced Petrochemical Process Technology III	2	-	2	2	-
PPT 422	Plastic Processing Technology	2	-	2	2	-
PPT 400	Final Year Project	-	-	6	-	-
	TOTAL	**18**	**-**	**26**	**20**	**-**
Petroleum Refining Option						
PRT 421	Petroleum Refining Processes III	2	-	2	2	-
PRT 400	Final Year Project	-	-	6	-	-
	TOTAL	**16**	**-**	**24**	**18**	**-**

YEAR 1 SEMESTER 1

PROGRAMME: HIGHER NATIONAL DIPLOMA (HND) IN PETROLEUM AND GAS PROCESSING ENGINEERING		
COURSE TITLE: Engineering Mathematics I	Code: **PGP 311**	CH: 2 CU: 2
	Pre-requisite: NIL	Theoretical: 2 Hours/week
Year: 1 Semester: 1		Practical: 0 Hours/week

Goal: This course is designed to provide the student with knowledge of calculus necessary for application in engineering and related areas.

General Objectives: On completion of this course, the students should be able to:

1.0 Comprehend Laplace transforms

2.0 Appreciate series and apply it to solve Engineering problems

3.0 Comprehend the methods of solving second order differential equation

4.0 Comprehend methods of solving simultaneous differential equations.

5.0 Comprehend methods of solving partial differential equations

6.0 Comprehend functions of several variables and their applications

7.0 Appreciate application of calculus in solving engineering problems

8.0 Appreciate Correlation and Regression Analysis

9.0 Comprehend probability distribution and its application in engineering

10.0 Comprehend the principle of reliability

11.0 Comprehend Basic Statistical experimental design

<table>
<tr><td colspan="7">Programme: Higher National diploma in Petroleum and Gas Processing Engineering Technology.</td></tr>
<tr><td colspan="4">COURSE TITLE: ENGINEERING MATHEMATICS I</td><td colspan="2">Code: PGP 311</td><td>CH: 2
CU:2</td></tr>
<tr><td colspan="4">Theoretical Content</td><td colspan="3">Practical Content</td></tr>
<tr><td colspan="7">General Objective 1.0: Comprehend Laplace transforms</td></tr>
<tr><td>Week</td><td>Specific Learning Outcomes</td><td>Teacher's Activities</td><td>Resources</td><td>Specific Learning Outcomes</td><td>Teacher's Activities</td><td>Evaluation</td></tr>
<tr><td>1</td><td>1.1 Define Laplace transform
1.2 Obtain Laplace transform of simple functions
1.3 Define the inverse Laplace transform
1.4 Obtain the inverse Laplace transform of simple functions
1.5 Carryout partial fraction expansion of function with
• Linear denominator
• Quadratic denominator
• Cubic denominator
1.6 Express derivatives in Laplace transform
1.7 Express unit step, impulse Dirac delta and ramp function in Laplace transform
1.8 Apply Laplace transform to solve differential equations with boundary value</td><td>Explain Laplace transform to obtain Laplace transform of simple functions and inverse Laplace transform of simple functions.

Explain the process of Carryout partial fraction expansion of function with
• Linear denominator
• Quadratic denomi</td><td>White board, recommended textbooks, lecture notes, etc.</td><td>-</td><td>-</td><td>Define Laplace transform and inverse Laplace transform

Express unit step, impulse Dirac delta and ramp function in Laplace transform</td></tr>
</table>

	problem 1.9 Apply Laplace transform to solve engineering problems	nator • Cubic denominator Describe ways of using Laplace transform to solve differential equations with boundary value problem to solve engineering problems				
	General Objectives 2.0:Appreciate series and apply it to solve Engineering problems					
2	2.1 Define Fourier series 2.2 Explain periodic function 2.3 Explain non-periodic function 2.4 Identify even and odd function 2.5 Explain even and odd function using graphical	Explain Fourier series Explain periodic function and non-periodic function, even	Whiteboard, Computer related software, projector, recommended text books, Lecture notes, and related journals	-	-	Define Fourier series Expand simple function in

	representations. 2.6 Explain the characteristics of even and odd function 2.7 Derive the Fourier coefficients in both polar and rectangular forms 2.8 Expand simple function in Fourier series 2.9 Derive the Fourier series for a trigonometric function using the half range approach 2.10 Expand functions with arbitrary period 2.11 State the Euler's formula 2.12 Establish a complex Fourier series 2.13 Evaluate the integration of Fourier series 2.14 Apply Fourier series to solve Engineering problems	and odd function using graphical. Explain the to derive the Fourier coefficients in both polar and rectangular forms and expand simple function in Fourier series and Fourier series for a trigonometric function using the half range approach.				Fourier series State the Euler's formula
General Objective 3: Comprehend the methods of solving second order differential equation						
3-4	3.1 Identify second order linear homogeneous differential equation 3.2 Explain second order differential equation with constant	Explain the identification of second order linear homogeneous	Whiteboard, Computer related software, projector, recommended text books,	-	-	Explain linear differential equations

	coefficients 3.3 Find the real and distinct, equal and complex roots for 3.2 above 3.4 Explain general and particular solution of differential equations 3.5 Describe the existence and uniqueness of solutions to second order differential equation problems 3.6 Explain homogeneous linear equations of higher order constant coefficients 3.7 Solve non-homogeneous differential equation	differential equation and second order differential equation with constant coefficients.	Lecture notes, and related journals.			Explain general and particular solution of differential equations
General Objective 4.0: Comprehend methods of solving simultaneous differential equations						
5	4.1 Solve simple simultaneous differential equations 4.2 Explain linear differential equation 4.3 Identify special cases of solving first-order differential equations 4.4 Apply the method of exact equations, separable variable to solve differential equation problems 4.5 Apply knowledge of	Explain and Solve simple simultaneous differential equations, linear differential equation and apply the method of exact equations, separable	Whiteboard, Computer related software, projector, recommended text books, Lecture notes, and related journals.	-	-	Describe how to solve simple simultaneous differential equations

	linear differential equation to suitable engineering problems	variable to solve differential equation problems				
General Objective 5.0: Comprehend methods of solving partial differential equations						
6	5.1 State partial differential equation of order 2 5.2 Solve partial different equation using separation of variables. 5.3 Apply D'Alembert's solution of the wave equation partial differential equation 5.4 Apply the Laplacian concept in poplar coordinate to partial differential equation problems	Explain activities in 5.1 to 5.2 Explain D'Alembert's solution of the wave equation partial differential equation and the Laplacian concept in poplar coordinate to partial differential equation problems	Whiteboard, Computer related software, projector, recommended text books, Lecture notes, and related journals.	-	-	State the methods used in solving partial differential equations

General Objective 6.0: Comprehend functions of several variables and their applications						
7-8	6.1 Explain limits and continuity of given function 6.2 Explain mean value theorem using total differentials 6.3 State Taylor's formula for function of several variables 6.4 Derive maxima and minima of function of several variables including possible saddle points 6.5 Establish the constrained maxima function of several variables 6.6 Define line integral in a plane 6.7 Explain the path of integral 6.8 Evaluate line integral problem 6.9 Define the green's theorem in a plane 6.10 Apply Greens theorem to solve line integrals problem 6.11 Apply Double integral to line	Explain activities in 6.1 to 6.2 Describe Taylor's formula for function of several variables and derive maxima and minima of function of several variables including possible saddle points and the constrained maxima function of several variables from the formular.	Whiteboard, Computer related software, projector, recommended text books, Lecture notes, and related journals.	-	-	Explain maxima and minima of function of several variables including possible saddle points Apply Greens theorem to solve line integrals problem Apply Stocks' formula to engineering problems

	integrals problems. 6.12 Apply changed of variables in triple integrals 6.13 Evaluate the differentiation under the integral sign 6.14 State Stock formula 6.15 Apply stocks formula to line integrates in space 6.16 Apply Stocks'formula to engineering problems					
General Objective 7.0: Appreciate application of calculus in solving engineering problems						
9	7.1 Solve first order differential equations problems in engineering 7.2 Solve second order differential equations problems in engineering 7.3 Solve partial differential equations problems in engineering	Explain first and second order differential equations in solving engineering problems.	Whiteboard, Computer related software, projector, recommended text books, Lecture notes, and related journals.	-	-	List examples of differential equations in engineering
General Objective 8.0: Appreciate Correlation and Regression Analysis						
10-11	8.1 Define dependent and independent variable 8.2 Explain linear regression 8.3 Explain correlation coefficient	Explain dependent and independent variable, linear regression and	Whiteboard, Computer related software, projector, recommended text books,	-	-	Explain linear regression

	8.4 Differentiate between R and R^2 8.5 Explain covariance 8.6 Explain Nonlinear regression 8.7 Explain sum of squares 8.8 Describe Least Squares Method 8.9 Explain Nonlinear regression models; logarithmic functions, trigonometric functions, exponential functions, power functions, Lorenz curves, Gaussian functions, and other fitting models. 8.10 Describe Curve Fitting using Linear and Nonlinear Regression 8.11 Explain Multiple Linear Regression (MLR) 8.12 Solve engineering problems involving linear and nonlinear regression	correlation coefficient to differentiate between R and R^2. Explain Nonlinear regression models; logarithmic functions, trigonometric functions, exponential functions, power functions, Lorenz curves, Gaussian functions, and other fitting models.	Lecture notes, and related journals.			Describe Least Squares Method State the following Nonlinear regression models; logarithmic functions, trigonometric functions, exponential functions, power functions, Lorenz curves, and Gaussian functions
General Objective 9.0: Comprehend probability distribution and its application in engineering						
12-13	9.1 Define Binomial distribution 9.2 Explain the characteristics of	Explain Binomial distribution	Whiteboard, Computer related software, projector,	-	-	Explain Binomial distribution

	Binomial distribution 9.3 Apply Binomial distribution to samples with replacement 9.4 Apply Binomial distribution to solve engineering problems 9.5 Define the normal distribution. 9.6 Explain the characteristics of normal distribution. 9.7 Describe normal distribution curve and the empirical rule. 9.8 Calculate probability given the mean and the standard deviation. 9.9 Calculate the deviation Z given the mean, standard deviation and a particular observation. 9.10 Calculate the area under the curve at different points from either side of the mean. 9.11 Apply Normal distribution curve to simple engineering problems. 9.12 Define Poisson's	Its characteristics, distribution to samples with replacement to solve engineering problems. Explain 9.7 to 9.18	recommended text books, Lecture notes, and related journals.			Explain normal distribution Explain Poisson's Distribution. Test for equality of means of given population using the t- test

	Distribution. 9.13 Explain the characteristics of Poisson's Distribution 9.14 Explain the quality control techniques in production process. 9.15 Explain acceptance sampling as applied to mass production. 9.16 Test for equality of means of given population using the t-test 9.17 Test for equality of variances using the F-test 9.18 Apply the chi-square test in statistical quality control.					
General Objective 10.0: Comprehend the principle of reliability						
14	10.1 Distinguish between validity and reliability. 10.2 List types of reliability testing. 10.3 State the procedures for determining test-retest reliability. 10.4 Apply test-rest reliability to samples. 10.5 State the procedure for deterring split half reliability. 10.6 Determine the	Explain the difference between validity and reliability and their applicatio ns. Explain the determination and the	Whiteboard, Computer related software, projector, recommended text books, Lecture notes, and related journals.	-	-	Explain validity and reliability Explain standard level of reliability

	reliability coefficient. 10.7 Determine the standard level of reliability	reliability coefficient and the standard level of reliability				
General Objective 11.0: Comprehend Basic Statistical experimental designs						
15	11.1 Describe various experimental designs e.g. complete randomized block design, Randomized complete block design, Split block design. Latin Squares. Graeco – Latin Squares. 11.2 List example of when any of 11.1 above can be used. 11.3 Enumerate the advantages and disadvantage of using the various designs in 11.1 above.	Explain various experimental designs e.g. complete randomized block design, Randomized complete block design, Split block design. Latin Squares. Graeco – Latin Squares with examples.	Whiteboard, Computer related software, projector, recommended text books, Lecture notes, and related journals.	-	-	Describe randomized block design State the advantages and disadvantages of using the various experimental designs

Programme: Higher National diploma in Petroleum and Gas Processing Engineering (Petrochemical and Gas Processing Option)		
Course Title: Advanced Petroleum and Gas Production Technology	**Code: PGP 312**	**Credit Hour: 2** **Credit Unit: 2**
	Pre-requisite: NIL	**Theoretical: 2 hours/week**
Year: 1 Semester: 1		**Practical : 0 hours/week**

Goal: This course is designed to acquaint students with the principles of oil and gas production.

General Objectives: On completion of the course, the student should be able to:

1.0 Appreciate basic principles of petroleum and gas exploration
2.0 Comprehend drilling and well completion
3.0 Outline the development of oil and gas fields.
4.0 Outline production techniques.
5.0 Apprehend crude oil and gas measurements.
6.0 Outline storage and measurements.
7.0 Appreciate workover operations**.**

Programme: Higher National Diploma (HND) in Petroleum and Gas Processing Engineering						
Course Title: Advanced Petroleum and Gas Production Technology			**Code: PGP 312**		**CH: 2 CU:2**	
Theoretical Content			**Practical Content**			
General Objectives 1.0 Appreciate basic principles of petroleum and gas exploration						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1-2	1.1 Define the earth and its structure. 1.2 Explain the evolution of sedimentary basin 1.3 Explain the origin of oil and gas. 1.4 Explain the movements, faults, folds and unconformity. 1.5 Explain the types of traps. 1.6 Describe aerial surveying method. 1.7 Explain the following: geological exploration methods, geophysical exploration (seismic, gravimetric). 1.8 Identify the equipment used in geological exploration. ate	Describe the processes involved in oil and natural gas formation in a source rock. Describe the various stages involve in the formation of petroleum system Describe the earth movements, and trap types. Explain the exploration methods. Describe the	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals. .	Identify the equipment used in geological exploration.	Guide students to identify the equipment used in geological exploration.	Explain the following: geological exploration methods, geophysical exploration (seismic, gravimetric).

		equipment used in geological exploration.				
General Objective 2.0:Comprehend drilling and well completion						
3-4	2.1 Explain the following: • Appraisal drilling. • Exploratory drilling. • Development drilling. • Deviated drilling. • Directional drilling. • Horizontal drilling. 2.2 Describe a drilling rig 2.3 Explain the drilling process 2.4 Describe offshore and swamp drilling. 2.5 Describe types of well completion. 2.7 Explain the following: casing and tubing assembly; casing strings, perforations, packers, tubing hangers, sand consolidation. 2.8 State the relevance of the well completion terms	State the types of drilling. Explain the drilling process. Explain the types of drilling rigs. Explain offshore drilling. Enumerate the different classes of oil and gas wells. Differentiate between casing and tubing assembly. Explain casing strings, packers and other well completion terms	White Boards, Computers, Related Software, PowerPoint Projectors, Flip Charts, Interactive-Boards, Recommended textbooks, lecture notes & Related Journals	-	-	Explain the following: casing and tubing assembly; casing strings, perforations, packers, tubing hangers, sand consolidation.

		and their importance.				
General Objective 3.0: Outline the development of oil and gas fields						
5	3.1 Explain the gathering systems. 3.2 Explain the functions of a flow station. 3.3 Describe the equipment used in the development of oil and gas fields such as: manifolds, separators, compressors, gas scrubbers, heater treaters, surge vessels etc.	Enumerate the various components of a flow station. Explain the operations and functions of flow stations.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	Describe the equipment used in the development of oil and gas fields such as: manifolds, separators, compressors, gas scrubbers, heater treaters, surge vessels etc.
General Objective 4.0: Outline production techniques						
6-7	4.1 Describe the following. - Primary recovery. - Secondary recovery. - Tertiary recovery 4.2 Explain well	Explain the types of recovery techniques. Describe well production	Whiteboard, Computer related software, PowerPoint projectors,	-	-	Explain well performance using pressure and production decline curve.

	performance with pressure and production decline curve. 4.3 State the types of reservoir fluids. 4.4 Explain the properties and characteristics of reservoir fluids (e.g. P.V.T data, viscosity, density, etc.). 4.5 Describe the following artificial lifting methods. ○ Gas lifting ○ Sucker rod ○ Centrifugal pumps ○ Hydraulic pumps ○ Electric submersible pumping.	performance with pressure and production decline curve. Enumerate the types of reservoir fluids, its properties and characteristics. Assess the students.	recommended text books, flip charts, lecture notes, and related journals			
General Objectives 5.0: Apprehend crude oil and gas measurements						
8-10	5.1 Explain the methods used for identifying the nature of fluids. 5.2 Identify the equipment used in crude oil and gas measurements (e.g. Orifice meters, flow charts, and PD meters).	Describe the process of identifying nature of fluids. Demonstrate the activities stated above.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts,	Identify the equipment used in crude oil and gas measurements (e.g. Orifice meters, flow charts, and PD meters).	Guide students to identify the equipment used in crude oil and gas measurements (e.g. Orifice meters, flow charts, and PD	Explain sampling by Basic Sediment and Water (BSW), Gas Liquid Ratio (GLR) etc.

	5.3 Explain the principles employed in the use of the equipment in 5.2. 5.4 Explain water measurement by the use of flocometer, and Water Oil Ratio (WOR). 5.5 Explain sampling by Basic Sediment and Water (BSW), Gas Liquid Ratio (GLR) etc. 5.6 Describe well head surveillance by Tubing Head Pressure (THP), Casing Head Pressure (CHP), Well Head Pressure (WHP) etc. 5.7 Perform the operations stated in 5.6.		lecture notes, and related journals		meters).	
General Objectives 6.0: Outline storage and measurements						
11-13	6.1 State the types of storage tanks and their applications. 6.2 Describe the features of the tanks in 6.1. 6.3 Describe the construction of storage tanks according to API standards.	Explain the importance of storage facilities in production. Highlight the importance of product measurement.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts,	-	-	Explain the significance of temperature in specific gravity (API), BSW and GLR for exporting crude oil and gas.

	6.4 Explain loses on storage tanks and the safety devices. 6.5 Describe tank farms, outline the layout, safety precautions and management involved. 6.6 Explain the determination of volume using meters and tank gauging (e.g. hydrostatic, and dip stick). 6.7 Explain the significance of temperature in specific gravity (API), BSW and GLR for exporting crude oil and gas.	Explain the characteristics of storage tanks and the various types. Explain storage construction according to API standard, its safety approach, layout and general management.	lecture notes, and related journals.			
General Objectives 7.0: Appreciate workover operations						
14-15	7.1 State the types of work over jobs and tools. 7.2 Explain well stimulation. 7.3 Describe production logging, types and applications. 7.4 Perform well testing	List the types of work over jobs and tools. Enumerate methods of production, logging and application. Enumerate well	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related	Perform well testing and sampling. Interpret well test data obtained from sampling.	Guide students to perform well testing and sampling. Guide students to interpret well test data obtained from sampling.	Describe production logging, types and applications.

	and sampling. 7.5 Interpret well test data obtained from sampling.	testing, sampling data and interpretation.	journals.			

Programme: Higher National diploma (HND) in Petroleum and Gas Processing Engineering		
Course Title: Separation Process I	**Code: PGP 313**	**Credit Hour: 2** **Credit Unit: 2.0**
	Pre-requisite: NIL	**Theoretical: 2 hours/week**
Year: 1 Semester: 1		**Practical : 0 hours/week**

Goal: This course is designed to enable students acquire the fundamental knowledge of liquid separations techniques.

General Objectives: On the completion of the course, the student should be able to:

1.0 Comprehend the applications of humidity data for air-water systems.

2.0 Appreciate the principles of water cooling.

3.0 Comprehend the theory and methods of investigating drying and enthalpy balances in continuous and batch dryers.

4.0 Appreciate the principles and applications of adsorption

5.0 Comprehend membrane separation.

Programme: Higher National diploma (HND) in Petroleum and Gas Processing Engineering						
Course Title: Separation Process I			Code: PGP 313		CH: 2	CU:2
Theoretical Content			Practical Content			
General Objective 1.0: Comprehend the applications of humidity data for air-water systems.						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1-2	1.1 Define the following terms: • Humidity. • Percentage humidity. • Humid heat. • Humid volume. • Relative humidity. • Wet-bulb temperature. • Adiabatic saturation temperature. 1.2 Describe the use of psychometric charts.	Explain the activities in 1.1. Show how the psychometric chart is used. Give numerical examples of how the psychometric chart is used.	White Boards, Computers, Related Software, PowerPoint Projectors, Flip Charts, Interactive Boards, Recommended textbooks, lecture notes & Related Journals Psychometric chart	Show how the psychometric chart is used.	Guide students to use psychometric chart	Define the following terms: • Humidity. • Percentage humidity. • Humid heat.

General Objective 2.0: Appreciate the principles of water cooling						
3-5	2.1 Explain the working principles of cooling towers. 2.2 Determine the height of a water-cooling tower. 2.3 Explain the correlation factor 'f' for obtaining driving force in a cooling towers. 2.4 Evaluate heat and mass transfer coefficients.	Explain the working principles of cooling towers Solve numerical problems on how to use the correlation factor, Evaluate heat and mass transfer coefficients. .	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals Cooling tower	Determine the height of a water-cooling tower	Guide students to determine the height of a water-cooling tower	Explain the working principles of cooling towers
General Objective 3.0: Comprehend the theory and methods of investigating drying and enthalpy balances in continuous and batch dryers						
6-10	3.1 Define moisture content on dry basis. 3.2 Define moisture content on wet basis. 3.3 Explain the various types of moisture. 3.4 Identify the various types of dryers. 3.5 Enumerate conditions for batch scale and scale-up operations. 3.6 Explain drying tests. 3.7 Explain rate of drying curves.	Explain moisture, moisture content, dryers and batch scale and scale-up operations. Explain drying test and techniques of drying. Solve numerical and graphical problems of	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals	Identify the various types of dryers	Guide students to identify the various types of dryers	Define moisture content on wet basis.

	3.8 Explain the techniques for evaluating time of drying. 3.8 Apply graphical and numerical solutions to drying problems. 3.9 Describe features of common industrial drying equipment. 3.10 Explain the operation of the equipment in 3.9	drying.				
General Objective 4.0 : Comprehend the principles and applications of adsorption						
11-13	5.1 Define adsorption 5.2 Explain the principles of adsorption. 5.3 Explain the following : a. Physisorption b. Chemisorption 4.1 List commercially available adsorbent and their applications. 4.2 Describe some methods of preparation of adsorbent 4.6 Explain adsorption equilibrium 4.7Explain heat of adsorption.	Explain condition under which adsorption is used in place of distillation as means of separation Give examples of adsorption equipment Explain some behaviors of adsorption isotherms. Calculate isostatic heat of	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals	-	-	Explain heat of Adsorption

		adsorption.				
General Objective 5.0: Comprehend membrane separation**.**						
14-15	5.1 Define membrane separation. 5.2 Classify membranes. 5.3 Explain membrane permeation of liquids and gases.	State different types of membranes and their application. Explain membranes for sulfur recovery and low molecular hydrocarbons	Recommended textbooks, Internet services, etc. White Board, Multimedia projector	-	-	State different types of membranes and their application

Programme: Higher National diploma (HND) in Petroleum and Gas Processing Engineering

Course: Chemical Process Laboratory Techniques **Year :1 Semester: 1**	**Code: PGP 314** **Pre-requisite:**	**Total Hours: 2 Hours/Week** **Theoretical hours: 0 Hour/Week** **Practical hours: 2 Hours/Week**
Goal: This course is designed to acquaint students on how to perform experiments using engineering equipment and pilot plants in unit operations, fluid mechanics, instrumentation, Process control and with the quality control procedures applicable to petroleum and its products.		

GENERAL OBJECTIVES	
On completion of this course, the students should be able to :	
1.0	Perform drying operation
2.0.	Perform experiment involving plate and packed columns, flow through pipe, process Control and instrumentation.
3.0.	Carry out experiments involving gas absorption and liquid-liquid extraction
4.0.	Carry out experiment involving fixed and fluidized bed and fluid transportation processes.
5.0.	Appreciate the determination of color of petroleum products
6.0	Appreciate the determination of smoke point of fuels
7.0	Comprehend the determination of flash point of fuels
8.0	Comprehend distillation of petroleum products
9.0	Comprehend ring and bail softening point of bituminous materials
10.0	Appreciate the determination of aniline points by thin film method.
11.0.	Comprehend cone penetration test of lubricating grease and bituminous materials.
12.0	Comprehend the calibration of peristaltic pumps
13.0	Appreciate the determination of vapor pressure of petroleum products

<table>
<tr><td colspan="7">Programme: Higher National diploma (HND) in Petroleum and Gas Processing Engineering</td></tr>
<tr><td colspan="4">Course Title: Chemical Process Laboratory Techniques</td><td>Code: PGP 314</td><td colspan="2">CH: 2 CU:2</td></tr>
<tr><td colspan="4">Theoretical Content</td><td colspan="3">Practical Content</td></tr>
<tr><td colspan="7">General Objective 1.0 : Perform drying operation</td></tr>
<tr><td>Week</td><td>Specific Learning Outcomes</td><td>Teacher's Activities</td><td>Resources</td><td>Specific Learning Outcomes</td><td>Teacher's Activities</td><td>Evaluation</td></tr>
<tr><td>1</td><td>-</td><td>-</td><td>Practical manuals , Dryers</td><td>1.1 Dry suitable material using the following
a. Rotary dryer
b. Tray dryer
c. Vertical Pneumatic dryer</td><td>Give a brief background of drying and demonstrate how drying is done using the dryers.</td><td>Compare tray dryer and vertical pneumatic dryer.</td></tr>
<tr><td colspan="7">General Objectives: 2.0 Perform Experiment Involving Plate And Packed Columns, Flow Through Pipe, Process Control And Instrumentation.</td></tr>
<tr><td>2-3</td><td>2.1 Describe the working of a packed distillation column and plate distillation.
2.2 Describe the relationship between pressure drops which occur when a fluid flows through an orifice plate and a venturi</td><td>Explain activities in 2.1 to 2.3</td><td>Practical manuals, laboratory scale packed and plate distillation column.
Fluid flow measuring devices and control</td><td>2.1 Determine the energy losses which occur when a fluid flows through pipe fittings.
2.2 Determine the drag coefficient for spheres.
2.3 Determine controller constant necessary to stabilize a thermal process using its sign curve.</td><td>The student should follow the instructions given in the manual and conduct the practical activities.</td><td>Explain the relationship between pressure drops which occur when a fluid flows through an orifice plate and a</td></tr>
</table>

	meters. 2.3 Describe the dynamic behavior of stirred tank		system.	2.4 Characterize the individual control element in a controller circuit. 2.5 Operate a feedback control loop and examine the effect of the control variable of temperature using a temperature control apparatus. 2.6 Investigate unsteady state behavior in the absence of control using a flow control apparatus. 2.7 Determine the hydraulic characteristics of model sedimentation tank, including --- circuiting, average retention times, hold -----and flow profiles as a function of flow rate.		
General Objective 3.0 : Carry Out Experiments Involving Gas Absorption And Liquid-Liquid Extraction						
4-5	-	-	Practical manual , Gas absorption and LL extraction equipment, pressure measuring	3.1 Operate gas absorption equipment's e.g. packed towers, plate or trays towers, spray towers, wetted wall absorption column. 3.2 Demonstrate solvent selectivity and solvent	The student should follow the instructions given in the manual and conduct the practical	Explain the effect of pressure drop, loading and flooding on packed absorption

			devices	recovery. 3.3 Determine the effect of pressure drop, loading and flooding on packed absorption column performance 3.4 Determine gas/liquid gas (sleeted pairs) overall mass transfer coefficients. 3.5 Determine theoretical equilibrium states for plate towers of gas/liquid system 3.6 Determine height equivalent to theoretical stages for packed towers. 3.7 Determine the effect of packing characteristics on gas –absorption efficiency 3.8 Determine hydrodynamics of liquid-liquid systems in packed towers. 3.9 Determine extraction efficiency for different packings.	activities.	
General Objective 4.0: Carry Out Experiment Involving Fixed and Fluidized Bed and Fluid Transportation Processes						
6	-	-	Practical manual , laboratory scale fixed and fluidized bed , pumps	4.1 Determine pressure drop through packed and fluidized beds for both air and water systems 4.2 Verify Carman-Kozeny	Briefly give background theory on fixed and fluidized bed.	Differentiate between particulate and aggregate fluidization

			and pressure measuring devices	equation. 4.3 Differentiate between particulate and aggregate fluidization. 4.4 Operate centrifugal pumps , gear pumps, axial pumps and positive displacement pumps and measure their operating characteristics including a. pump head flow head characteristics at constant feed b. Pump performance characteristics c. Determination of the relationship between speed, flow ,head and power absorbed d. Power input characteristics e. Impeller radial pressure distribution.	The student should follow the instructions given in the manual and conduct the practical activities.	
General Objective 5.0: Appreciate the determination of color of petroleum products						
7	5.1 Define color 5.2 Identify comparator apparatus. 5.3 Describe successive steps of the test procedure. 5.4 Explain the	Explain the significance of color test on petroleum products, the ASTM color	Whiteboard, Computer related software, PowerPoint projectors, recommended	Carry out ASTM color test Identify the lovibond Tintometer for color test.	Guide students to carry out ASTM color test Guide students	State the importance of color test of petroleum products.

	significance of color test on petroleum products. 5.5 Explain the ASTM color test. 5.6 Carry out ASTM color test 5.7 Identify the lovibond Tintometer for color test. 5.8 Explain colour nomenclature in the lovibond system. 5.9 Describe successive steps of test procedure 5.10 Identify dull and bright samples. 5.11 Carry out colour test using lovibo Tintometer.	test. Identify the lovibond Tintometer for color test. Explain colour nomenclature in the lovibond system	text books, flip charts, lecture notes, and related journals.	Identify dull and bright samples. Carry out colour test using lovibo Tintometer.	to identify the lovibond Tintometer for color test. Guide students to identify dull and bright samples. Guide students to carry out colour test using lovibo Tintometer.	
General Objective 6.0: Appreciate the determination of smoke point of fuels						
8	6.1 Define smoke of fuels 6.2 State the significance of smoke point 6.3 Identify and draw the smoke point lamp. 6.4 Identify and draw	Describe smoke of fuels and its significance. Identify and draw the smoke point	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts,	Identify the smoke point lamp. Draw the smoke point lamp	Guide students to identify and draw the smoke point lamp. Guide students to identify and draw the smoke	Explain the importance of smoke point of petroleum products.

	the smoke point lamp. 6.5 Describe successive steps of the test procedure. 6.6 Carry out smoke point determination of fuel.	lamp, smoke point lamp. Explain successive steps of the test procedure in smoke point determination of fuel.	lecture notes, and related journals.	Carry out smoke point determination of fuel.	point lamp Guide students to carry out smoke point determination of fuel.	
General Objective 7.0: Comprehend the determination of flash point of fuels						
9	7.1 Define flash point of fuels 7.2 State the significance of the test. 7.3 Identify the Pensky-Martens Flashpoint. 7.4 Describe steps of the test procedure. 7.5 State the precautions to be taken during the test. 7.6 Carry out flashpoint test of fuels	Explain flash point of fuels, precautions to be taken during the test and flashpoint test of fuels.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	Identify the Pensky-Martens Flashpoint Carry out flashpoint test of fuels	Guide students to identify the Pensky-Martens Flashpoint Guide students to carry out flashpoint test of fuels	Explain the importance of flashpoint of petroleum products.

General Objective 8.0: Comprehend distillation of petroleum products						
10	8.1 Define distillation 8.2 Identify a distillation unit. 8.3 Describe successive steps of the test procedure. 8.4 State the significance of distillation as volatility test of fuels.	Explain activities 8.1 to 8.5	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	Identify a distillation unit. Draw a distillation unit Make a graphical presentation of result obtained in carrying out the test and interpret it.	Guide students to identify a distillation unit. Guide students to draw a distillation unit Guide students to make a graphical presentation of result obtained in carrying out the test and interpret it.	Explain the importance of the distillation of petroleum products.
General Objective 9.0: Comprehend ring and bail softening point of bituminous materials						
11	9.1 Define softening point 9.2 Identify the apparatus for the determination of softening point 9.3 Explain the preparation of sample for the test. 9.4 Describe the successive test procedure. 9.5 State the significance of the	Discuss the softening point of bituminous materials and the apparatus involved.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	Identify the apparatus for the determination of softening point Carry out softening point of bituminous materials	Guide students to identify the apparatus for the determination of softening point Guide students to carry out softening point of bituminous materials	State the importance of the softening point of bituminous materials.

	test. 9.6 Carry out softening point of bituminous materials					
General Objective 10.0: Appreciate the determination of aniline points by thin film method.						
12	10.1.Define Aniline point State the significance of the test. 10.2.Enumerate the apparatus for determination of aniline points by thin film method. 10.3.List the precautionary measures to be adopted during the test. 10.4.Describe successive test procedures.	Explain the Aniline point and the apparatus used in testing it.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	Identify the apparatus for determination of aniline points Carry out aniline point test as measure of aromatic content of a fuel.	Guide students to identify the apparatus for determination of aniline points Guide students to carry out aniline point test as measure of aromatic content of a fuel.	Explain the importance of the Aniline point measurements.
Objective 11.0: Comprehend cone penetration test of lubricating grease and bituminous materials.						
13	11.1.Define penetration test. 11.2.State the significance of penetration test. 11.3.Identify the apparatus for cone	Explain activities in 11.1 to 11.6	Whiteboard, Computer related software, PowerPoint projectors, recommended	Identify the apparatus for cone penetration test.	Guide students to identify the apparatus for cone penetration test.	Explain the importance of the penetration test measurements.

	penetration test. 11.4.Describe successive steps of each form penetration test. 11.5.State precautionary measures associated with test procedures. 11.6.Explain process of penetration test of lubricating grease and bituminous materials. 11.7.Present graphically the relationship between penetration and softening point of a bitumen material.		textbooks, flip charts, lecture notes, and related journals.	Carry out penetration test of lubricating grease and bituminous materials. Present graphically the relationship between penetration and softening point of a bitumen material.	Guide students to carry out penetration test of lubricating grease and bituminous materials. Guide students to present graphically the relationship between penetration and softening point of a bitumen material.	
General Objective 12.0: Comprehend the calibration of peristaltic pumps						
14	12.1.Describe a peristaltic pump 12.2.State the importance of peristaltic pump 12.3.Identify the peristaltic pump.	Explain activities in 12.1 to 12.8	Whiteboard, Computer related software, PowerPoint projectors, recommended	Identify the peristaltic pump Carry out tests using	Guide students to identify the peristaltic pump Guide students to carry out tests	State the significance of calibrating a peristaltic pump.

	12.4. Describe the successive steps of calibrating pump before being used. 12.5. Carry out tests using peristaltic pump. 12.6. Interpret the graph drawn with tabulated result. 12.7. Differentiate between laminar and turbulent flow. 12.8. State the significance of calibrating a peristaltic pump.		text books, flip charts, lecture notes, and related journals.	peristaltic pump.	using peristaltic pump.	
General Objective 13.0: Appreciate the determination of vapor pressure of petroleum products						
15	13.1 Explain vapour pressure of petroleum products. 13.2 Identify a vapour pressure Reid equipment. 13.3 Explain sample preparation for the vapor pressure test. 13.4 State the	Explain vapour pressure of petroleum products, vapour pressure Reid equipment. Explain sample	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	Identify a vapour pressure Reid equipment. Carryout vapour pressure test on fuels.	Guide students to identify a vapour pressure Reid equipment Guide students to carryout vapour pressure test on fuels.	State the importance of the vapor pressure measurements.

	significance of the test. 13.5 Describe the successive test pressure procedure. 13.6 Explain the method of rectifying uncorrected vapor pressure read from the gauge. 13.7Explain weathering losses and the effects of vapour pressure on startup of a car engine. 13.8Carryout vapour pressure test on fuels.	preparation for the vapor pressure test and the significance of the test.				

Programme: Higher National Diploma(HND) Petroleum and Gas Processing Engineering		
Course Title: Advanced Transport Phenomena I	**Code: PGP 315**	**Credit Hour: 2** **Credit Unit:2**
	Pre-requisite:	**Theoretical: 2 hours/week**
Year: 1 Semester: 1		**Practical : 0 hours/week**

Goal: This course is designed to enable student have general understanding of fluid transport properties

General Objectives: On the completion of the course, the student should be able to:

1.0 Comprehend the principles of momentum transport in fluid flow.

2.0 Appreciate types of fluid flow existing in pipes and other ducts.

3.0 Comprehend energy losses in pipes and fittings

4.0 Comprehend fluid displacement equipment

5.0 Appreciate particle mechanics

Programme: Higher National diploma in Petroleum and Gas Processing Engineering (Petrochemical and Gas Processing Option).						
Course Title: Advanced Transport Phenomena I			**Code: PGP 315**		**CH: 2**	**CU: 2**
Theoretical Content			**Practical Content**			
General Objective 1.0 : Comprehend the principles of momentum transport in fluid flow						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1-3	1.1 Explain the basic principles of the kinetic theory of gases. 1.2 Describe the deformation of a fluid acted upon by a shearing force. 1.3 Derive Newton's law of viscosity for fluids. 1.4 Explain the elements of boundary layer theory. 1.5 Explain the nature of laminar flow (near solid surfaces). 1.6 Explain Poiseiulle's law 1.7 Draw velocity profiles for fluid flow in pipes.	Explain the boundary layer theory. Make sketches of the velocity profiles for flow of fluids through pipes.	Maker & whiteboard PC & projector	-	-	Explain the difference between Newtonian and non-Newtonian fluids.

	1.8 Explain the variation of viscosity with temperature. 1.9 Explain the difference between Newtonian and non-Newtonian fluids. 1.10 Describe the effects of non-Newtonian fluids on process operations.					
General Objective 2.0: Appreciate the types of fluid flow existing in pipes and other ducts.						
4	2.1 Explain Reynolds's number as a dimensionless group. 2.2 Calculate Reynolds number for a number of flow systems. 2.3 Describe the nature of turbulent flows. 2.4 Describe velocity profiles for	Explain activities in 2.1 to 2.4	Recommended texts, scientific calculator, internet services, etc.	-	-	Describe the nature of turbulent flows

	turbulent flow on a duct.					
General Objective 3.0: Comprehend energy losses in pipes and fittings t						
5-8	3.1 Explain the Darcy equation. 3.2 Explain the Fanning friction factor. 3.3 Explain the function of Reynolds number. 3.4 Ascertain friction factors using the Stanton plot. 3.5 Calculate pressure drop and energy losses in pipes. 3.6 Calculate pressure drop in pipes making allowances for losses in pipes and fittings 3.7 Explain the factors affecting optimum pipe diameter for simple cases. 3.8 Explain the Chezy equation for flow in open	Mention the various ways through which energy losses are encountered in the flow of fluid through pipes. .	Recommended texts, scientific calculator, internet services, etc.	-	-	Explain the Fanning friction factor.

	channels and hydraulic pumps. 3.9 Calculate flow in various designs of open ducts. 3.10 Design weirs and notches to measure flows in open ducts. 3.11Calculate coefficient of discharge of a weir. 3.11 Calculate the sizes of pipe required for specific duties					
General Objective 4.0: Comprehend fluid displacement equipment						
9-12	4.1 Describe the construction and operation of various types of positive displacement pumps. 4.2 Explain the functions of different types of valves used in pumps. 4.3 Describe the	Explain the various ways through which energy could be added to a flow system. Explain to the students the operations of centrifugal and positive displacement pumps. Solve problems on	Recommended texts, scientific calculator, internet services, etc. Pump text rig, recommended textbooks, internet services, etc.	Determine centrifugal pump characteristics	Guide students to determine centrifugal pump characteristics	Explain the functions of different types of valves used in pumps.

	construction and operation of different types of rotary pumps. 4.4 Describe an air lift pumps. 4.5 Explain the output characteristics of positive displacement pumps. 4.6 Calculate the energy requirements and pump efficiency of different type of pumps. 4.7 Describe the construction and operation of centrifugal pumps. 4.8 Describe the construction and operation of compressors and air blowers. 4.9 Determine centrifugal pump characteristics. 4.10 Compare	determination of pump characteristics, power requirement and pump efficiency.	Centrifugal pump.			

	operating characteristics of a centrifugal pump with those of a positive displacement pump. 4.11 Specify centrifugal pump for a pipe network system. 4.12 Define net positive suction head. 4.13 Explain cavitation. 4.14 Calculate power requirements for pumps. 4.10 Explain how two pumps may be made to work together.					
General Objective 5.0 Appreciate particle mechanics						
13-15	5.1 Develop the Stokes equation of motion for a single particle in a fluid. 5.2 Develop the concept of drag coefficient as	Develop the Stokes equation of motion for a single particle in a fluid and the concept of drag coefficient as function of Reynolds number.	Recommended textbooks, fluidized bed, equipment, internet services, etc.	-	-	State the advantages of the fluidized bed the fixed bed.

	function of Reynolds number. 5.3 Develop the Carman-Kozeny equation for flow through packed beds. 5.4 Calculate the pressure drop for flow of fluids through a packed bed. 5.5 Explain fluidization and fluidization mechanism 5.6 Explain the properties of fluidized bed. 5.7 Explain the effects of the following on fluidization: a. Minimum porosity b. Bed height c. Pressure drop d. Minimum fluidization velocity					

	e. Bed expansion. 5.8 Calculate the parameters ofthe fluidized bed as in (5.7) above. 5.9 State the advantages of the fluidized bed the fixed bed. 5.10 List industrial applications of fluidization.					

PROGRAMME: HIGHER NATIONAL DIPLOMA (HND) IN PETROLEUM AND GAS PROCESSING ENGINEERINGTECHNOLOGY		
COURSE TITLE: Corrosion Control	Code: PGP 316	CH: 3 CU: 3
	Pre-requisite:	Theoretical: 2 Hours/week
Year: 1 Semester: 1		Practical: 1 Hours/week

Goal: This course is designed to provide the student with knowledge of science of material, corrosion science and control

General Objectives: On completion of this course, the students should be able to:

1.0 Appreciate atomic structure and the significant of electrons and bonding
2.0 Comprehend Properties of engineering materials
3.0 Comprehend corrosion and the significance of corrosion control
4.0 Appreciate forms of corrosion
5.0 Comprehend corrosion testing
6.0 Appreciate corrosion of materials and protective measures
7.0 Appreciate resistant properties of materials used in chemical plant
8.0 Comprehend corrosion protection methods
9.0 Appreciate corrosion in petroleum and gas processing plant

PROGRAMME: Higher National diploma in Petroleum and Gas Processing Engineering Technology.						
COURSE TITLE: Corrosion Control				**Code: PGP 316**		**CH:3 CU:3**
Theoretical Content				**Practical Content**		
General Objective 1.0: Appreciate atomic structure and the significant of electrons and bonding						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1-3	1.1 Explain atomic structure 1.2 Explain the concept of the following atomic bonding: • ionic bonding • covalent bonding • metallic bonding • Van der Waals bonding • hydrogen bonding 1.3 Describe bonding forces and energies 1.4 Explain: • Structure of metals • space lattices • allotropy • solid solutions • intermetallic compounds (alloys) • molecular structure and lattices • crystal structure and lattices • crystal directions and planes	Explain activities in 1.1 to 1.5 Show physical models of crystalline and non-crystalline materials	Whiteboard, projector, recommended text books, Lecture notes, and related Journals Physical models of crystalline and non-crystalline materials	-	-	Describe atomic bonding in solids State the difference between primary and secondary bonding in solids

	• non-crystalline (amorphous) structures 1.5 Explain: • Crystal imperfections • Dislocation • Slips • Twining • Simple dislocation theory • Work hardening • Cold working • Impure phase					
General Objectives 2.0: Comprehend Properties of engineering materials						
4	2.1 Explain Electrical properties of engineering materials 2.2 Explain Thermal properties of engineering materials 2.3 Explain Optical properties of engineering materials 2.4 Explain Magnetic properties of engineering materials 2.5 Explain Mechanical properties of engineering materials	Explain activities in 2.1 to 2.5	Whiteboard, projector, recommended text books, Lecture notes, and related Journals	-	-	Enumerate Properties of engineerin g materials relevant to the oil and gas industry
General Objective 3.0: Comprehend corrosion and the significance of corrosion control						
5 - 6	3.1 Define corrosion 3.2 State the objective of corrosion studies 3.3 State classes of corrosion 3.4 Estimate the cost of corrosion in petroleum refining 3.5 Estimate the cost of corrosion in gas processing 3.6 Estimate the cost of corrosion in	Explain activities in 3. 1 to 3.6	Whiteboard, projector, recommended text books, Lecture notes, and related Journals	-	-	Explain why metals corrode Estimate the cost of corrosion in the oil

	petrochemical industry					and gas industry
General Objective 4.0: Appreciate forms of corrosion						
7 - 8	4.1 Describe corrosion mechanism 4.2 Relate corrosion tendency to electrode potential 4.3 Define polarization 4.4 Explain passivity and corrosion rate expressions 4.5 Explain the characteristics, effects, prevention and beneficial applications of: • Galvanic corrosion • Crevice corrosion • Pitting • Intergranular corrosion • Selective leaching • Erosion corrosion • Stress corrosion 4.6 Identify hydrogen damage 4.7 Explain the effects of oxygen oxidizers, velocity, temperature, concentration, galvanic coupling and metallic properties on the different forms of corrosion.	Explain activities in 4.1 to 4.7	Whiteboard, projector, recommended text books, Lecture notes, and related Journals. Corrosion study kits	Carryout stress corrosion experiment. Carryout brine and oxygen environment corrosion studies Perform galvanic action	Guide the student to conduct the practical activities	Explain the mechanism of corrosion State the different forms of corrosion
General Objective 5.0: Comprehend corrosion testing						
9	5.1 State the objectives of corrosion testing 5.2 Describe corrosion testing methods applicable to the various forms of corrosion 5.3 Describe the specimen and its surface preparation for testing 5.4 Interpret corrosion testing results obtained experimentally	Explain corrosion testing methods	Whiteboard, projector, recommended text books, Lecture notes, and related Journals. Corrosion test	Perform influence of pH on corrosion experiment	Guide students to carry out influence of pH on corrosion experime	Describe corrosion testing methods applicable to the various

			kits		nt.	forms of corrosion
General Objectives 6.0: Appreciate corrosion of materials and protective measures						
10 - 11	6.1 List the types of protective measures taken against materials corrosion. 6.2 Explain anodic and cathodic protection 6.3 Describe polymer deposition on materials as a protective measure taken against materials corrosion 6.4 Explain the principles of electroplating 6.5 Define anodizing 6.6 Describe the anodizing process of aluminum 6.7 Describe conversion coating	Explain activities 6.1 to 6.7	Whiteboard, projector, recommended text books, Lecture notes, and related Journals. Corrosion study kits	Perform corrosion inhibition Perform cathodic protection byimpressed voltage Perform electrolytic corrosion	Guide the student to conduct the practical activities	List the types of protective measures taken against materials corrosion Describe conversion coating

General Objective 7.0: Appreciate resistant properties of materials used in chemical plant						
12	7.1 Describe the resistance of materials against corrosion 7.2 Explain the chemical resistance of materials against corrosion 7.3 Explain the mechanical resistance of materials against corrosion 7.4 Explain the thermal properties and resistances of materials against corrosion 7.5 Identify the area of application and types of materials in the construction of chemical plant	Explain activities as in 7.1 to 7.5	Whiteboard, projector, recommended text books, Lecture notes, and related Journals.	-	-	Explain the chemical resistance of materials against corrosion
General Objective 8.0: Comprehend corrosion protection methods						
13 - 14	8.1 Enumerate corrosion protection methods 8.2 Explain the role of metal purification, metals, non-metal and alloys in the materials selection methods. 8.3 Describe the role of inhibitors and changing media in the alteration of environmental effect. 8.4 State the design rules for wall thickness 8.5 Estimate excess wall thickness in the design methods. 8.6 Compare the anodic and cathodic protection methods 8.7 Explain the general characteristics of the use of coating in corrosion control. 8.8 State the limitations of the corrosion protection methods.	Explain the role of inhibitors in corrosion control Explain anodic and cathodic protection.	Whiteboard, projector, recommended text books, Lecture notes, and related Journals, corrosion study kit.	Carry out anodic and cathodic protection of a given metal	Guide students to carry out practical activities	Enumerate corrosion protection methods State the limitations of corrosion protection methods
General Objective 9.0: Appreciate corrosion in petroleum and gas processing plant						
15	9.19 Identify the major corrosion area in a typical oil gas facility	Explain activities in 9.1 to 9.3	Whiteboard, projector,	-	-	Identify

	9.20 List prevention methods in 9.1 9.3 Compare corrosion in petroleum, gas processing, and petrochemical plant		recommended text books, Lecture notes, and related Journals.			the major corrosion area in a typical oil gas facility

Course Title: Catalysis of Petrochemical Processes	**Code: PGP 317**	**Credit Hour: 2** **Credit Unit:2**
	Pre-requisite:	**Theoretical: 2 hours/week**
Year: 1 Semester: 1		**Practical : hours/week**

Goal: This course is designed to enable students to acquire the underlying principle of catalytic phenomena, preparation and characterization of catalyst materials, application of catalyst in petrochemical industry

General Objectives: On the completion of the course, the student should be able to:

1.0 Appreciate the fundamental principle of catalysis, catalyst and catalytic reaction

2.0 Comprehend catalytic materials and their properties

3.0 Identify methods of catalysts preparation

4.0 Identify methods of catalysts characterization

5.0 Appreciate the application of catalyst in petrochemical processes

Programme: (Higher National Diploma) in Petroleum and Gas Processing Engineering						
Course Title: Catalysis of Petrochemical Processes			**Code: PGP 317**		**CH: 2 CU:2**	
Theoretical Content			**Practical Content**			
General Objective 1.0: Appreciate the fundamental principle of catalysis, catalyst, catalytic reaction						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1-3	1.1 Define catalyst and explain the concept of catalysis 1.2 Give a brief history of catalyst technology 1.3 Enumerate the importance of catalysis and catalytic technology 1.4 Explain the effect of catalyst on activation energy of a reaction 1.5 Describe the structure of a catalyst 1.6 Explain homogeneous and heterogeneous catalyst	• Explain the concept of catalysis • Explain the relevance of catalytic technology to modern life • Illustrate with a diagram the activation energy of a catalyzed and un-catalyzed reaction • Illustrate the structure of a heterogeneous catalyst • Explainthe basic molecular processes in a catalytic reaction	Recommended textbooks, Internet services, etc. White Board, Multimedia projector	-	-	State the importance of catalysis in petrochemicals Enumerate the effects of catalyst in reaction path

	1.7 Outline the steps involve in catalytic reaction 1.8 Explain adsorption and desorption on catalyst surface					
General Objective: 2.0: Comprehend catalytic materials and their properties						
4-6	2.1 Outline materials used as heterogeneous catalyst 2.2 Enumerate properties of heterogeneous catalyst 2.3 Describe the difference between bulk catalyst and supported catalyst 2.4 Outline desirable characteristics of a catalyst support 2.5 Define molecular sieves and zeolites 2.6 Explain the composition and structure of zeolite 2.7 Explain pore	• Explain the make-up of heterogeneous catalyst • Describe Active phases, Carriers and Promoters • List the physical, mechanical and chemical properties of catalyst • Outline the uses of molecular sieves and zeolites • Depict the structure of Zeolite	Recommended textbooks, Internet services, etc. White Board, Multimedia projector	-	-	Explain pore structure of molecular sieves Explain the term Turn Over Frequency (TOF)

	structure of molecular sieves 2.8 Explain catalytic activity 2.9 Explain the term Turn Over Frequency (TOF)					
General Objective: 3.0 : Identify methods of catalysts preparation						
7-8	3.1 Explain the catalyst precipitation 3.2 Describe Gelation and flocculation 3.3 Describe hydrothermal transformation 3.4 Describe decantation, filtration, centrifugation and washing 3.5 Describe drying of catalyst	• Explain unit operations involve in preparation of catalyst • State the importance of forming operation • Outline various forming operation • State conditions in catalyst drying and calcination processes • Illustrate with a diagram stages of	Recommended textbooks, internet services Whiteboard multimedia projector Chemicals for catalyst preparation and clay Oven furnace weighing	Prepare catalyst from alumina silica and zeolite with metals doped	Guide students to prepare catalyst from alumina silica and zeolite with metals doped	Explain forming operation in catalyst preparation

	3.6 Describe calcination process 3.7 Explain forming operation in catalyst preparation 3.8 Describe precipitation and impregnation methods of supported catalyst preparation 3.9 Describe steps in preparation of Zeolite catalyst 3.10 Illustrate the technique of dispersion of active species on to catalyst support material.	supported catalyst preparation	balance filtration unit glassware			
General Objectives 4.0: Identify methods of catalysts characterization						
9-12	4.1 Define catalyst characterization 4.2 Outline various techniques used in catalyst characterization 4.3 Outline catalyst characteristics and their methods of investigation	• Explain the meaning and importance of catalyst characterization • List common techniques used in characterization of catalyst	Recommended textbooks, internet services Whiteboard multimedia projector	Characterize basic catalyst prepared for desired catalyst properties	Guide students to characterize basic catalyst prepared for desired catalyst properties	Express catalyst characterization techniques that can be used to monitor specific desired catalyst

	4.4 Explain the meaning of surface area, pore size and pore volume 4.5 Describe method of measurement of surface area, pore size and pore volume using Brunauer Emmett Teller (BET) 4.6 Calculate BET surface area from N_2 adsorption data 4.7 Calculate mesopore size distribution from desorption data 4.8 Explain determination of elemental composition using XRF 4.9 Describe phase/crystallinity determination using XRD. 4.10Describe determination of surface texture and morphology using SEM. 4.11Explain the term surface acidity	• Explain surface area, pore size and pore volume • Illustrate calculation of BET from N_2 adsorption data • Illustrate the determination of mesopore size distribution from desorption data • Describe working principles of XRF, XRD, SEM, and TEM • Explain techniques used in determination of surface acidity i.e. TPD, FTIR and NMR • Show spectra of typical XRD, TPD, FTIR and NMR result • Give interpretation	XRF, XRD, FTIR AND SEM Uv-VIS			properties State the application of X-ray photoelectron spectroscopy (XPS).

	4.12Explain the term surface reactivity 4.13Describe Electron Microscopy as tool for determination of surface texture, morphology, and crystallite. 4.14 Describe chemisorption as a method for measuring dispersion. 4.15 Describe Infrared and NMR analysis. 4.16 Describe the application of Temperature-programmed desorption. 4.17 State the application of X-ray photoelectron spectroscopy (XPS). 4.18 Explain the application of Ultraviolet-visible spectrometry (UV-	of XRD, TPD, FTIR and NMR spectra				

	VIS). 4.19 Describe scheme for catalyst selection and design.					
General Objectives 5.0: Appreciate the application of catalyst in petrochemical processes						
13-15	5.1. Explain catalytic reforming of Naphtha for hydrogen and synthesis gas production 5.2. Outline the reaction steps and catalyst used in steam reforming of Naphtha 5.3. Describedeactivation and regeneration of steam reforming catalysts 5.4. Distinguish between High and Low-Temperature Water-Gas-Shift 5.5. Explain the development of Ammonia Synthesis by Haber Process	• Depict process route based on catalytic reforming and partial oxidation of Naphtha • Draw process flow diagram for reforming process • Explain deactivation and regeneration of steam reforming catalysts • Explain the Haber process • State the catalysts and the condition involve in Haber Process • Explain catalyst poisoning in Haber	Recommended textbooks, internet services Whiteboard multimedia projector Batch reactor Fixed bed reactor Fluidized bed reactor Gas chromatography	Test reforming naphtha using prepared catalyst Determine via qualitative and quantitative techniques the deactivation of catalyst Determine conversion and selectivity in Haber process Determine conversion and selectivity in methanol synthesis	Guide students to conduct the practical activities.	Explain the reaction conditions and catalyst used in dehydrogenation reaction Describe with the aid a process flow diagram the catalytic dehydrogenation of ethylbenzene to styrene Describe Alkylation process Describe the catalyst and the actions of the

	5.6. State the reactions, and conditions involve in Haber Process 5.7. List the constituents of a catalyst system used in Haber Process 5.8. Explain catalyst deactivation in Haber Process 5.9. Describe the evolution of Methanol synthesis 5.10. State the reactions, and conditions involve in Methanol synthesis 5.11. List commercial catalysts employed in Methanol synthesis 5.12. Explain catalyst deactivation in Methanol synthesis 5.13. Explain the development of	process • Explain Methanol synthesis with the aid of process flow diagram • ExplainHigh and Low-Temperature Water-Gas-Shift • Explain Haber Process • Depict a schematic process flow diagram of Haber Process • Explain catalyst design in Haber Process • Explain FTS with the aid of a process flow diagram • Describe the reaction mechanism of FTS • List production distribution of FTS • Explain the				catalyst involved in the production of LAB, LABS, and SLABS.

	Fischer-Trøpsch synthesis (FTS) 5.14. State the application of FTS 5.15. State the reactions, and conditions involve in FTS 5.16. Explain the Carbone mechanism reaction pathway for FTS 5.17. Explain active sites and roles of surface structure of FTS catalysts system 5.18. State production distribution of FTS base on Iron and Cobalt slurry catalyst 5.19. List out common promoters and their effect in FTS 5.20. List and discuss the causes,	importance of promoters in FTS • Describe catalyst deactivation in FTS • Sketch schematic of different reactor design in FTS • Draw a process flow diagram of FST • Outline the stages of aromatization reaction • Draw the structures of BTX • Explaindehydrogen ation of light hydrocarbons • Draw a schematic of a typical dehydrogenation process • Write the reaction equation for LAB production				

	prevention and treatment of catalyst deactivation in FTS 5.21. Explain typical catalyst regeneration in FTS 5.22. Explain briefly the type of reactor designs used in FTS 5.23. Describe aromatization reaction 5.24. State condition in aromatization reaction 5.25. Describe catalytic dehydrogenation of light hydrocarbons 5.26. State the reaction conditions and catalyst used in dehydrogenation reaction 5.27. Describe with the aid a process flow diagram the catalytic	• Write the reaction equation for LAS production • Draw process flow diagram for LAB production • State the catalyst and reaction condition in LAB production • Describe the catalyst and the actions of the catalyst involved in the production of LAB, LABS, and SLABS.				

	dehydrogenation of ethylbenzene to styrene 5.28. Describe Alkylation process 5.29. Outline catalyst used in Alkylation process 5.30. State the use of Zeolite in Alkylation 5.31. Describe Pacol process for linear alkyl benzene (LAB) production from n-paraffin's 5.32. Explain sulphonation of LAB for the production of linear alkyl sulphonic acid(LAS) and neutralisation of Linear Alkyl BenzeneSulphonic (LABS) with NaOH to give SodiumLinear AlkylBenzeneSulphonate (SLABS)					

Programme: Higher National Diploma (HND) in Petroleum and Gas Processing Engineering		
Course Title: Advanced Petrochemical Process Chemistry	**Code: PPT 311**	**Credit Hour: 2** **Credit Unit:2**
	Pre-requisite:	**Theoretical: 2 hours/week**
Year: 1 Semester: 1		**Practical : 0 hours/week**

Goal: This course is designed to acquaint the students with the general physical and chemical characteristics of petroleum and its products.

General Objectives: On completion of the course, the student should be able to:

1.0 Identify the primary raw materials for petrochemicals, intermediates and end products.

2.0 Appreciate chemicals based on ethylene.

3.0 Appreciate chemicals based on propylene.

4.0 AppreciateC4 olefins and diolefins based chemicals.

5.0 Appreciate chemicals based on benzene, toluene, and xylenes.

6.0 Appreciate the polymerization processes

7.0 Identify the synthetic petroleum-based polymers

Programme: Higher National Diploma (HND) Petrochemical and gas processing Engineering						
Course Title: Advanced Petrochemical Process Chemistry			**Code: PPT 311**		**CH: 2**	**CU:2**
Theoretical Content			**Practical Content**			
General Objective 1.0: Identify the primary raw materials for petrochemicals, intermediates and end products						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1-2	1.1 State the composition of both non-associated and associated natural gases. 1.2 Explain natural gas treatment processes. 1.3 State the composition and properties of crude oils. 1.4 Explain crude oil classification. 1.5 Describe paraffinic, olefinic and diolefinic(dienes) hydrocarbons. 1.6 Describe aromatic hydrocarbons. 1.7 Describe crude oil fractionation for petrochemicals 1.8 Describe the absorption and adsorption	Explain natural gas and its properties. Explain the production of various hydrocarbon intermediates along with other crude oil processing techniques. Explain the Sulphur and its functions. Explain carbon black, its properties and functions. Explain synthesis gas, its properties and uses.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	State the composition of natural gas State composition and properties of crude oil Classify crude oil

	processes. 1.9 Describe the chemistry of Sulphur recovery 1.10 Explain the uses of Sulphur. 1.11 Describe carbon black. 1.12 Describe the chemicals based on methane, ethane and propane.	Explain Naphthenic acids and cresylic acids. Explain the chemicals that can be produced from methane, ethane and propane.				
General Objective 2.0: Appreciate chemicals based on ethylene						
3-4	2.1 Describe the chemicals based on ethylene such as ethylene oxide. 2.2 Describe the chemistry of ethylene oxide. 2.3 Describe the derivatives of ethylene oxide such as ethylene glycol 2.4 Describe the chemistry of acetaldehyde. 2.5 Explain the important chemicals from acetaldehyde. 2.6 Describe the hydration of ethylene.	Explain the chemicals that can be produced from ethylene. Explain the production of ethylene oxide. Explain Chemicals from Acetaldehyde.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	Describe the chemistry of ethylene oxide. Describe alkylation using ethylene.

	2.7 Describe oligomerization of ethylene. 2.8 Describe alkylation using ethylene.					
General Objectives 3.0: Appreciate chemicals based on propylene						
5-6	3.1 Describe oxidation of propylene. 3.2 Describe oxy-acylation of propylene. 3.3 Explain the chlorination and hydration of propylene. 3.4 Describe the addition of organic acids to propylene. 3.5 Describe hydro formylation of propylene: the Oxo reaction. 3.6 Describe the disproportionation of propylene. 3.7 Describe alkylation using propylene.	Explain oxidation of propylene. Explain the ox-acylation of propylene. Explain the chlorination of propylene. Explain the hydration of propylene.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals	-	-	Express the reaction of oxidation, ox-acylation, chlorination and hydration of propylene

General Objective 4.0: Appreciate C4 olefins and diolefins based chemicals						
7-8	4.3 Explain chemicals from butylene. 4.4 Explain chemicals from isobutylene. 4.5 Describe chemicals from butadiene.	Explain natural gas and its properties. Describe the techniques used in processing natural gas. Explain the classification of crude oil. Explain complex carbonaceous materials and possible future energy sources.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	State chemicals produced from butylene, isobutylene and butadiene
General Objective 5.0: Appreciate chemicals based on benzene, toluene, and xylenes.						
9-10	5.1 Describe the reactions and chemicals derived from benzene. 5.2 Describe reactions and chemicals derived from toluene. 5.3 Describe reactions and chemicals derived from xylene.	Explain the reactions and chemicals derived from benzene. Explain the reactions and chemicals derived from toluene. Explain the chemicals derived from xylenes.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	State the properties of Benzene, Toluene, and Xylenes Express the chemicals reactions of producing chemicals from

						Benzene, Toluene, and Xylenes
General Objectives 6.0: Appreciate the polymerization processes						
11-12	6.1 Describe monomers, polymers, and copolymers. 6.2 Describe polymerization reactions. 6.3 Explain addition polymerization. 6.4 Describe condensation polymerization. 6.5 Describe polymerization methods. 6.6 Explain physical properties of polymers.	Explain the monomers, polymers, and copolymers. Explain the polymerization reactions. .	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	Differentiate between monomers, polymers and copolymers Express reactions for polymerizatio n

General Objective 7.0: Identify the synthetic petroleum-based polymers						
13-14	7.1 Describe thermoplastics resins. 7.2 Explain thermosetting plastics. 7.3 Describe synthetic rubber. 7.4 Describe synthetic fibers.	Explain the thermoplastics resins. Explain synthetic rubber. Describe synthetic fibers.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	State the application of thermoplastics , synthetic fibers, and synthetic rubber in engineering

PROGRAMME: HIGHER NATIONAL DIPLOMA HND PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY		
COURSE TITLE: Advanced Petroleum Chemistry	**Code: PRT 311**	**Credit Hour: 2** **Credit Unit: 2**
	Pre-requisite:	**Theoretical: 2 hours/week**
Year: 1 Semester: 2		**Practical : 0 hours/week**

Goal: This course is designed to acquaint students with additional knowledge of the chemistry of petroleum conversion processes.

General Objectives:

On the completion of the course, the student should be able to:

1.0 Appreciate the Chemical Composition of Petroleum
2.0 Comprehend Catalysts for conversion processes
3.0 Comprehend the chemistry of paraffins dehydrogenation processes
4.0 Comprehend the chemistry of hydrodesulfurization processes
5.0 Comprehend the chemistry of hydrodenitrification processes
6.0 Comprehend the chemistry of alkylation processes
7.0 Comprehend the chemistry of hydrodealkylation processes
8.0 Comprehend the chemistry of Isomerization processes
9.0 Comprehend the chemistry of thermal and catalytic cracking
10.0 Comprehend the chemistry of acid gas removal and dehydration in natural gas

PROGRAMME: HIGHER NATIONAL DIPLOMA HND PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (PETROCHEMICAL AND POLYMER OPTION)

COURSE TITLE: ADVANCED PETROLEUM CHEMISTRY				**Code: PRT 311**		**CH:2** **CU:2**
Goal: This course is designed to acquaint students with additional knowledge of the chemistry of petroleum conversion processes						
General Objective 1.0: Appreciate the Chemical Composition of Petroleum						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1	1.1 Identify the chemical composition of petroleum. 1.2 Explain paraffins, naphthenes, and aromatics 1.3 Explain sulphur containing compounds 1.4 Explain nitrogen containing compounds 1.5 Explain oxygen containing compounds 1.6 Describe organometallic compounds 1.7 State the effects of non-hydrocarbons on petroleum processing	Describe the hydrocarbon and non-hydrocarbon components of petroleum	White board, computer related software textbooks, journals, internet materials. Related journals	-	-	State the hydrocarbon and non-hydrocarbon components of petroleum
General Objectives 2.0: Comprehend Catalysts for conversion processes						
2	2.1 Describe catalysts for hydrogenation/dehydrogenation 2.2 Describe catalysts for cracking 2.3 Describe catalysts for desulfurization 2.4 Describe catalysts for isomerization 2.5 Describe catalysts for	Discuss the catalysts processes in 2.1 to 2.5	White board, textbooks, journals, internet materials.			State the catalyst used in each of the major conversion processes

	hydrodealkylation					
General Objectives 3.0: Comprehend the chemistry of paraffins dehydrogenation processes						
3-4	3.1 Explain the mechanism of paraffins dehydrogenation 3.2 Describe the catalyst for dehydrogenation of paraffins 3.3 Explain the reaction conditions for dehydrogenation of paraffins 3.4 explain the effects of process variables on dehydrogenation of paraffins	Discuss the mechanisms of paraffins dehydrogenation in 3.1 to 3.4	White board, textbooks, journals, internet materials.	-	-	State the reaction conditions for dehydrogenation of paraffins
General Objectives 4.0: Comprehend the chemistry of hydrodesulfurization processes						
5-6	4.1 Explain the mechanism of hydrodesulfurization 4.2 Describe the catalyst for hydrodesulfurization 4.3 Explain the reaction conditions for hydrodesulfurization 4.4 Explain the effects of process variables on hydrodesulfurization	Explain the concept catalyst and its properties: activity, stability and selectivity. State types of catalyst: homogeneous and heterogeneous.	White board, textbooks, journals, internet materials.	-	-	State the reaction conditions for hydrodesulfurization
General Objectives 5.0: Comprehend the chemistry of hydrodenitrification processes						
7	5.1 Explain the mechanism of hydrodenitrification 5.2 Describe the catalyst for hydrodenitrification 5.3 Explain the reaction conditions for hydrodenitrification 5.4 explain the effects of process	Explain hydrodenitrificati on	White board, computer, related software, projector, lecture notes, e-books	-	-	Explain the mechanism of hydeodenitrification

	variables on hydrodenitrification		textbooks, journals, internet materials.			
General Objectives 6.0: Comprehend the chemistry of alkylation processes						
8-9	6.1 Explain the mechanism of alkylation 6.2 Describe the catalyst for alkylation 6.3 Explain the reaction conditions for alkylation 6.4 Explain the effects of process variables on alkylation	Explain the activities in 6.1 to 6.4	White board, computer, related software, projector, recommended textbooks, lecture notes, e-books & related journals,	-	-	Explain the effects of process variables on alkylation products
General Objectives 7.0: Comprehend the chemistry of hydrodealkylation processes						
10	7.1 Explain the mechanism of hydrodealkylation 7.2 Describe the catalyst for hydrodealkylation 7.3 Explain the reaction conditions for hydrodealkylation 7.4 explain the effects of process variables on hydrodealkylation	Explain the activities in 7.1 to 7.4	White board, computer, related software, projector, recommende d textbooks, lecture notes, e-books & related journals.	-	-	State the catalyst for hydrodealkylation
General Objectives 8.0: Comprehend the chemistry of Isomerization processes						
11	8.1 Explain the mechanism of	Explain the	White board,	-	-	Explain the

	Isomerization 8.2 Describe the catalyst for Isomerization 8.3 Explain the reaction conditions for Isomerization 8.4 Explain the effects of process variables on Isomerization	activities in 81 to 8.4	computer, related software, projector, recommended textbooks, lecture notes, e-books & related journals.			mechanism of Isomerization
General Objectives 9.0: Comprehend the chemistry of thermal and catalytic cracking						
12-13	9.1 Describe the mechanism of cracking 9.2 Explain the reaction conditions for cracking 9.3 Explain the effects of process variables on cracking	Explain mechanism of cracking Explain the activities in 9.2 to 9.3	White board, computer, related software, projector, recommended textbooks, lecture notes, e-books & related journals.	-	-	State the reaction conditions for cracking
General Objectives 10.0: Comprehend the chemistry of acid gas removal and dehydration in natural gas						
14-15	10.1 Describe the chemistry of acid gas removal from natural gas 10.2 Describe the chemistry of dehydration of natural gas 10.3 Explain the reaction conditions in 10.1 and 10.2 10.4 Explain the effects of process variables on acid gas	Explain the chemistry of acid gas removal and dehydration of natural gas	White board, computer, related software, projector, recommended textbooks, lecture notes, e-books &	-	-	Describe the chemistry of acid gas and dehydration of natural gas

	removal and dehydration		related journals.			

YEAR 1 SEMESTER 2

Programme: Higher National Diploma (HND) in Petroleum and Gas Processing Engineering		
Course Title: Engineering Mathematics II	**Code: PGP 321**	**Credit Hour: 2** **Credit Unit: 2**
	Pre-requisite: NIL	**Theoretical: 2 Hours/week**
Year: 2 Semester: 1		**Practical : 0 Hours/week**

Goal: This course is designed to acquaint students with the knowledge of differential calculus

General Objectives: On completion of this course, the students should be able to:

1.0 Comprehend the concept of Matrices.
2.0 Comprehend the use of numerical methods in solving sets of linear and nonlinear equations.
3.0 Appreciate the techniques of numerical differentiation.
4.0 Identify the techniques of numerical integration.
5.0 Appreciate numerical methods in solving first and second order ordinary differential equations (ODE).
6.0 Comprehend hyperbolic, exponential and logarithmic functions.
7.0 Appreciate the principles of vector algebra
8.0 Comprehend the concept and application of complex numbers.

Programme: Higher National Diploma (HND) in Petroleum and Gas Processing Engineering						
Course Title: Engineering Mathematics II			**Code: PGP 321**		**CH: 2**	**CU: 2**
Theoretical Content			**Practical Content**			
Goal: This course is designed to acquaint students with the knowledge of differential calculus						
General Objective 1.0 : Comprehend the concept of Matrices						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1-2	1.1 Define with examples, types of matrices; Null, Square, Diagonal, Identity, Singular, etc. 1.2 Form sets of linear equations from matrices 1.3 Perform matrices operations: addition, subtraction and multiplication. 1.4 Determine the transpose, determinant, cofactor and adjoint of a matrix. 1.5 Solve sets of linear equations using the following methods: • Matrix inversion • Gaussian Elimination • Determinant.	Explain the concepts of topics covered in 1.1 to 1.5 Deduce examples from distillation, gas absorption and reactions engineering, etc. Supervise student exercises and assess student work.	White Board, Computers, Related Software, Projector, Recommended textbooks, lecture notes, e-books & Related Journals	–	–	Solve sets of linear equations using the following methods; • Matrix inversion • Gaussian Elimination and • Determinant

General Objectives 2.0 Comprehend the use of numerical methods in solving sets of linear and non-linear equations**.**						
3-4	2.1 Solve linear algebraic equations using; • Guass-Seidel method. • Jacobi method 2.2 Use Newton-Raphson iterative formulae to solve non-linear equations e.g. find the roots of $\cos x = x^2$.	Explain the concepts covered in 2.1 – 2.2 Supervise student exercises and assess student work	White Board, Computers, Related Software, Projector, Recommended textbooks, lecture notes e-books & Related Journals	-	-	Solve linear algebraic equations using; • Guass-Seidel method. • Jacobi method
General Objective 3.0: Appreciate the techniques of numerical differentiation						
5	3.1 Explain the basic processes of numerical differentiation up to the third derivative. 3.2 Explain differentiation based on equal interval interpolation formula. 3.3 Evaluate higher order derivatives. 3.4	Explain the concepts covered in 3.1 – 3.3. Supervise student exercises and assess student work	White Board, Computers, Related Software, Projector, Recommended textbooks, lecture notes, e-books & Related Journals	-	-	Evaluate higher order derivatives.
General Objective 4.0: Identify the techniques of numerical integration.						
6-8	4.1 Evaluate integrals using the following rules; • Trapezoidal • Simpson's one – third. • Simpson's three- eighth. 4.2 Evaluate the integral of unequally space data points	Explain the concepts covered in 4.1 - 4.2. Supervise student exercises and assess student work	White Board, Computers, Related Software, Projector, Recommended textbooks, lecture notes, e-books & Related	-	-	Evaluate integrals using rules; • Trapezoidal • Simpson's one – third. • Simpson's

			Journals			three-eighth.
General Objective 5.0: Appreciate numerical methods in solving first and second order ordinary differential equations.						
9-11	**5.1** Explain the following methods; • Euler method • Modified Euler method • Runge-Kutta method. **5.2** Solve 1st order ordinary differential equation using: • Euler Method • Modified Euler Method **5.3** Solve 2nd order ordinary differential equation using Runge-Kutta's method. **5.4** Solve engineering problems using methods in 5.1 – 5.3 such as the Hougen and Watson's analysis of Kessel's data for homogeneous vapour-phase dehydrogenation of benzene.	Explain the concepts covered in 5.1 - 5.4 Supervise student exercises and assess student work.	White Board, Computers, Related Software, Projector, Recommended textbooks, lecture notes, e-books & Related Journals	-	-	Solve problems like the Hougen and Watson's analysis of Kessel's data for homogeneous vapour-phase dehydrogenation of benzene
General Objective 6.0: Comprehend hyperbolic, exponential and logarithmic functions						
12-13	6.1 Define hyperbolic sine and cosine function in terms of exponential functions. 6.2 Draw the hyperbolic graphs for sine, cosine and tangent. 6.3 Transform hyperbolic to trigonometric function 6.4 Evaluate inverse trigonometric function 6.5 Review logarithmic function 6.6 Solve problems involving hyperbolic, exponential and logarithmic functions.	Explain the activities in 6.1 to 6.4 Explain logarithmic functions	White Board, Computers, Related Software, Projector, Recommended textbooks, lecture notes & Related Journals			Draw the hyperbolic graphs for sine, cosine, and tangent.

General Objective 7.0: Appreciate the principles of vector algebra						
14	7.1 Explain the addition, subtraction and multiplication vectors. 7.2 State the divergence theorem 7.3 Explain surface integrals and volume integrals 7.4 State Stoke's theorem 7.5 Evaluate certain integrals using Stoke's formula 7.6 Explain certain integrals and vector differential gradient and divergence. 7.7 Apply the analysis to engineering problems	Discuss the various vectors Explain the activities in 7.2 to 7.6 Discuss the analysis of vectors as applicable to engineering problems	White Board, Computers, Related Software, Projector, Recommended textbooks, lecture notes & Related Journals			Explain surface integrals and volume integrals State Stoke's theorem Explain vectors application to resolving engineering problems
General Objective 8.0: Comprehend the concept and application of complex numbers						
-15	8.1 Explain complex numbers. 8.2 Explain rectangular and polar forms of a complex numbers 8.3 Explain the addition, subtraction, multiplication and division of complex numbers 8.4 Compute modulus and argument of complex numbers 8.5 Define complex numbers using Argand's diagram 8.6 Explain addition and subtract of two complex numbers using Argand's diagram 8.7 State De Moivre's theorem for an integer (positive and negative).	Explain the activities in 8.1 to 8.4 Explain the addition and subtraction of complex numbers using Argand's diagram Explain the activities in 8.7 to 8.10	White Board, Computers, Related Software, Projector, Recommended textbooks, lecture notes & Related Journals	-	-	Explain rectangular and polar forms of a complex number Define a complex number using Argand's diagram State De Moivre's theorem for an

	8.8 Apply De Moivre's theorem to alternating current 8.9 Solve equation involving two or more complex numbers 8.10 Explain rationalization of complex numbers					integer

Programme: Higher National Diploma in Petroleum and Gas Processing Engineering Technology		
Course Title: Computer Application in Process Engineering	**Code: PGP 322**	**Credit Hour: 4** **Credit Unit: 2**
	Pre-requisite: Nil	**Theoretical: 2 hours/week**
Year: 1 Semester: 2		**Practical :2 hours/week**

Goal: This course is designed to provide basic knowledge and skills on the applications of computer tools in solving problems related to Gas Processing, Petroleum Refining and Petrochemical Production.

General Objectives: On the completion of the course, the student should be able to:

1.0 Comprehend Microsoft Excel in solving process engineering problems

2.0 Comprehend Object-Oriented Programming (OOP) language

3.0 Comprehend MATLAB for solving mathematical problems

4.0 Comprehend MATLAB for solving numerical methods problems

5.0 Comprehend Process Simulator for Solving Process Engineering Problems

6.0 Comprehend Process Simulator for solving Gas Processing/Petroleum Refining/Petrochemical Production Problems

Programme: Higher National Diploma in Petroleum and Gas Processing Engineering Technology						
Course Title: Computer Application in Process Engineering				**Code: PGP 322**	**CH: 3**	**CU:2**
Theoretical Content				**Practical Content**		
General Objective 1.0: Comprehend Microsoft Excel in solving process engineering problems						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1-2	1.1 Explain Worksheet Basics 1.2 List arithmetic operators 1.3 List Relational/logical operators 1.4 Explain operator precedence 1.5 Explain formulas in Microsoft Excel 1.6 Explain mathematical and statistical functions 1.7 Explain Engineering and Financial functions 1.8 Explain Graphical Representation 1.9 Explain Matrix operations 1.10 Use "Solver" in Microsoft excel to solve iterative and optimization	Explain activities in 1.1 to 1.11	Recommended textbooks, Computers, Relevant Software (Microsoft Excel 2016 or later version)	-	-	Explain formulas in Microsoft Excel Describe the use of "Solver" in Microsoft excel to solve iterative and optimization problems

	problems 1.11 Explain Visual Basic Application VBA for Microsoft Excel					
General Objective 2.0: Comprehend Object-Oriented Programming (OOP) language						
3-4	2.1 Explain the programming language Integrated Development Environment (IDE). 2.2 Explain the components of the programming language 2.3 State basic arithmetic operators in the programming language 2.4 Explain operator precedence 2.5 Explain inbuilt functions 2.6 Explain data type 2.7 Explain how to format output 2.8 Explain control constructs 2.9 Explain conditional execution using 'if' statement. 2.10 Explain conditional execution using the 'Select Case' or 'Switch Case' statement. 2.11 Explain iteration using	Select one of the following programming languages to :- Explain activities in 2.1 to 2.11; Python, PHP, Java Script, C++, etc.	Recommended textbooks, internet materials, Computer with relevant compiler/interpreter, etc	-	-	State basic arithmetic operators in the programming language Apply the Programming language to solve a typical engineering problem

	looping statements. 2.12 Describe Graphic User Interface (GUI) 2.13 Explain how to develop and deploy an application. 2.14 Explain the application of programming language to solve Chemical Engineering problems					
General Objective 3.0: Comprehend MATLAB for solving mathematical problems						
5-6	3.1 Explain basic mathematical operations in MATLAB Command Window. 3.2 Explain how to input Polynomials, and Matrices in MATLAB 3.3 Explain library functions in MATLAB 3.4 Explain MATLAB functions used in numerical methods 3.5 Explain Symbolic Operations in MATLAB 3.6 Explain writing codes in MATLAB m-file 3.7 Explain creating functions in MATLAB.	Use MATLAB to explain activities in 3.1 to 3.8	Recommended textbooks, Computers, Relevant Software (Microsoft Excel 2016 or later version)	Perform basic mathematical operations in MATLAB Command Window Input Polynomials, and Matrices in MATLAB Write codes in MATLAB m-file (script file)to solve engineering problem Plot different types of Graphs using MATLAB.	Guide students to conduct the practical activities.	State the MATLAB functions used in numerical methods Describe how to plot Graphs in MATLAB

	3.8 Explain Graph plotting in MATLAB.					
General Objective 4.0: Comprehend MATLAB for solving numerical methods problems						
7-10	3.1 Explain Gauss Elimination Method Algorithm for solving Linear Equation (LE). 3.2 Explain how to write MATLAB Built-In Functions to solve Systems of LE. 3.3 Explain how to write MATLAB Program using MATLAB Built-In Functions to solve systems of LE with application in Chemical Engineering. 3.4 Explain Polynomial Equations for solving Nonlinear Equation (NLE). 3.5 Explain Newton-Raphson Method Algorithm for solving 3.6 Explain the solution of Nonlinear Equations of Several Variables. 3.7 Explain how to write MATLAB Program implementing Newton-Raphson Method Algorithm to solve systems of NLE with	Use MATLAB to explain activities in 3.1 to 3.17	Recommended textbooks, Computers, Relevant Software (MATLAB R2020)	-	-	Describe common in-built functions for handling Array.

	application Chemical Engineering. 3.8 Explain how to write MATLAB Program using MATLAB Built-In Functions to solve systems of nonlinear equations with application in chemical engineering. 3.9 Explain Runge-Kutta Method for solving ODE. 3.10 Explain how to write MATLAB Program using MATLAB Built-In Functions to solve Ordinary Differential Equations (ODE) with application in Chemical Engineering. 3.11 Explain how to write MATLAB Program using MATLAB Built-In-Functions to solve ODE with application in Chemical Engineering. 3.12 Write MATLAB Program using MATLAB Built-In-Functions to solve Systems of ODE with application in chemical engineering 3.13 Explain Linear					

	Regression Analysis 3.14 Explain Polynomial Regression Analysis 3.15 Explain Data Fitting by Least-Square Method 3.16 Explain how to write MATLAB Program using MATLAB Built-In Functions to solve linear regression problems with application in Chemical Engineering. 3.17 Write MATLAB Program using MATLAB Built-In Functions to solve nonlinear regression problems with application in Chemical Engineering.					
General Objectives 5.0: Comprehend Process Simulator for Solving Process Engineering Problems						
11-12	5.1 Explain the benefits of process simulation 5.2 Review the capabilities of ASPEN HYSYS for the gas processing, refining, petrochemical, polymer production plants 5.3 Explain the concept of process simulation and some of its advantages and applications.	Use ASPEN HYSYS to explain activities in 5.1 to 5.7	Recommended textbooks, Computers, Relevant Software (ASPEN One 11.0)	5.1 Build a 2-phase separator. 5.2 Analyse a 2-phase separator.	Show how ASPEN Hysys Method Assistant can be used to select the most suitable thermodynamic model for gas processing, petrochemical, and petroleum	Explain the concept of thermodynamic model selection in ASPEN HYSYS.

	5.4 Explain the concept of thermodynamic model selection in ASPEN HYSYS. 5.5 Implement activities in 5.1 to5.4 in a simple hydrocarbon separation process 5.6 Explain the typical workflow for ASPEN HYSYS simulations, utilizing the Properties and Simulation environments. 5.7 Explain common elements of the user interface, some useful keyboard shortcuts, where to access additional resources, some tips for building effective models, and how to troubleshoot models.				refining	
General Objectives 6.0: Comprehend Process Simulator for solving Gas Processing/Petroleum Refining/Petrochemical Production Problems						
13-15	6.1 Explain connecting unit operations to build a flow sheet 6.2 Explain using available tools to manipulate the ASPEN HYSYS user	Use ASPEN HYSYS to Explain activities in 6.1 to 6.22	Recommended textbooks, Computers, Relevant Software	Build a Refrigerated Gas Plant, Gas Gathering and Crude Pre-Heat Train, LNG, NGL, Ammonia, Methanol, VDC, and ADC.	Demonstrate how to build a Gas Gathering and Crude Pre-Heat Train, LNG, NGL,	Build a Gas Gathering and Crude Pre-Heat Train, LNG, NGL, Ammonia,

	interface 6.3 Explain viewing and customizing the ASPEN HYSYS Workbook 6.4 Explain converting a simulation case to a template 6.5 Explain Utilising the Heat Exchanger model in ASPEN HYSYS. 6.6 Explain the utilisation of the Compressor model in ASPEN HYSYS. 6.7 Explain the utilisation of the Heat Exchanger model in ASPEN HYSYS. 6.8 Explain the utilisation of the Reactor Model in ASPEN HYSYS. 6.9 Explain the utilisation of the Distillation Column model in ASPEN HYSYS 6.10 Explain the introduction of mathematical operations, starting with the Balance and Adjust 6.11 Explain adding a Template file to an existing simulation. 6.12 Explain the		(ASPEN One 11.0)		Ammonia, Methanol, VDC, and ADC.	Methanol, VDC, and ADC.

	Introduction of ASPEN HYSYS column models and templates 6.13 Explain how to use the Input Expert to add and define a distillation column. 6.14 Explain how to add and manipulate column specifications to meet process objectives. 6.15 Explain how to include column side operations for additional distillation configuration options. 6.16 Explain the use of Activated Analysis for continuous evaluation of economics, energy usage, equipment design, and dynamic modelling. 6.17 Explain using “Pinch technology” for minimizing energy use and optimizing heat exchangers. 6.18 Explain the identification of best practices for using ASPEN HYSYS 6.19 Explain the reasons why a simulation may					

	produce poor results or errors. 6.20 Explain how to use suggested tips to debug an ASPEN HYSYS simulation. 6.21 Explain the ASPEN HYSYS Assay Management features 6.22 Explain how ASPEN HYSYS Assay Management features can be used for assay characterization.						

Programme: Higher National Diploma (HND) in Petroleum and Gas Processing Engineering		
Course Title: Separation Process II	**Code: PGP 323**	**Credit Hour: 2** **Credit Unit:2**
	Pre-requisite: PGP 313	**Theoretical: 2 hours/week**
Year: 1 Semester: 2		**Practical 0 : hours/week**

Goal: This course is designed to enable students acquire knowledge on liquid distillation and some solid-liquid separation

General Objectives: On the completion of the course, the student should be able to:

1.0 Appreciate the principles and practice of evaporative systems

2.0 Comprehend the process of liquid-liquid extraction.

3.0 Appreciate factors influencing solvent selection.

4.0 Identify extraction equipment

5.0 Appreciate the principles and applications of leaching operations

6.0 Comprehend the principles and practice of crystallization processes.

Programme: Higher National Diploma (HND) in Petroleum and Gas Processing Engineering (Petrochemical and Gas Processing Option).						
Course Title: Separation Process II				**Code: PGP 323**		**CH: 2 CU:2**
Theoretical Content				**Practical Content**		
General Objective 1.0 : Appreciate the principles and practice of evaporative systems						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1-4	1.1 Explain evaporation. 1.2 Draw constructional details of the following: a. Vertical short tube evaporators. b. Vertical long tube climbing and falling film evaporators. c. Vertical cylindrical evaporators. d. Scrapped surface evaporators. 1.3 Describe equipment used for a. Vapour recompression; b. Operation under vacuum.	Explain in detail evaporation and evaporators, including types and conditions governing their choice. Explain multiple effect evaporators, with emphasis on dulling charts, optimum number of effects, and heat and material balances.	Marker & whiteboard , PC & Projector Recommended text.	Draw constructional details of the following: e. Vertical short tube evaporators. f. Vertical long tube climbing and falling film evaporators. g. Vertical cylindrical evaporators. h. Scrapped surface evaporators. Carry out heat and material balance calculations for single effect evaporators including vapour recompression types. Carry out heat and mass balances for double	Guide student to conduct the practical activities.	Explain the principle of multiple effect evaporators

	1.4 State the factors governing choice of evaporators and the operating conditions. 1.5 Execute energy and material balance calculations for single effect evaporators including vapour recompression types. 1.6 Explain the principle of multiple effect evaporators. 1.7 Describe the factors governing the choice of forward, backward, mixed and parallel feed methods for multiple effect evaporators. 1.8 Explain the effect of boiling point elevation and read dulling charts. 1.9 Explain the			effect evaporators		

	optimum number of effects and the steam economy of multiple effect evaporators. 1.10 Carry out heat and mass balances for double effect evaporators. 1.11 Explain the principles of, and the reasons for freeze drying. 1.12 Evaluate heat and material balance in the case of item (1.11) above. 1.13 Calculate apparent overall heat transfer coefficient for a climbing film evaporator.					
General Objective 2.0: Comprehend The Process Of Liquid-Liquid Extraction.						
4-6	2.1 Explain the rate of the feed solvent, the extraction solvents and the solute in an extraction process. 2.2 Distinguish	Draw a sketch to explain explicitly feed extraction solvent, solute, raffinate and extract.	Marker & whiteboard , PC & Projector Recommended	Plot immiscible equilibrium data for water, ternary systems such as water -carbon tetrachloride benzoic system acid.	Guide students to conduct the practical activities.	Distinguish between raffinate and extract solutions

	between raffinate and extract solutions. 2.3 Define the rate of an ideal stage in liquid-liquid extraction. 2.4 Plot immiscible equilibrium data for water, ternary systems such as water -carbon tetrachloride benzoic system acid. 2.5 Distinguish between immiscible and partially miscible solvent systems. 2.6 Calculate by graphical construction, the stage requirements or extraction performance when the solvents are immiscible. 2.7 Analyze the difference between the methods used in item (2.6) above when the solutions are dilute and concentrated.	Distinguish between immiscible and partially miscible solvent systems. Solve an appreciable number of problems to highlight particularly, the graphical method of solution.	text.	Construct a plot of a typical equilibrium data for ternary systems in triangular co-ordinates		

	2.8 Construct a plot of a typical equilibrium data for ternary systems in triangular co-ordinates. 2.9 Apply the Lever rule in such a diagram in item (2.8) above. 2.10 Analyze the diagram in item (2.8) above to evaluate the performance of a single theoretical stage with Subsequent solvent recovery. 2.11 Analyze the diagram for the estimation of stage requirements in counter current contacting device.					
General Objective 3.0: Appreciate Factors Influencing Solvent Selection.						
7-8	3.1 Explain the effect of selection and solubility on the efficiency of extraction. 3.2 Explain the effects of density, viscosity	Explain activities in 3.1 to 3.3	Marker & whiteboard , PC & Projector Recommended text.	-	-	Explain the effects of density, viscosity and interfacial tension on mixing and

	and interfacial tension on mixing and phase separation. 3.3 Describe the effect of other solvent properties on the operation and economics of extraction process.					phase separation.
General Objective 4.0 Identify extraction equipment						
9-10	4.1 Describe mixer-settler equipment. 4.2 Explain the concept of liquid at interface levels in Atmospheric equipment. 4.3 Describe the flow pattern in multiple stage mixer-settlers. 4.4 Distinguish between dispersed and continuous phase in spray columns. 4.5 Explain the advantages of plate columns over spray	Explain the concepts of Mixers and settlers. Distinguish between single-stage and multiple Stage mixer settlers, and plate and spray columns.	Marker & whiteboard , PC & Projector Recommended text.	-	-	Distinguish between dispersed and continuous phase in spray columns.

	columns. 4.6 Explain the effects of wettability in packed columns. 4.7 Explain the advantages of, and difficulties associated with the input of mechanical energy into counter current columns.					
General Objective 5.0 : Appreciate the principles and applications of leaching operations						
11-13	5.1 Explain the principles of leaching. 5.2 Explain the significance of leaching equations. 5.3 Describe single-stage and multi-stage leaching operations. 5.4 Calculate single-stage and multi-stage efficiencies. 5.5 State the factors governing the choice of leaching equipment and operating conditions.	Explain the concept of leaching carefully. Distinguish between single-stage and multistage leaching operations	Marker & whiteboard , PC & Projector Recommended text.	-	-	State the factors governing the choice of leaching equipment and operating conditions.

General Objective 6.0: Comprehend The Principles And Practice Of Crystallization Processes.						
14-15	6.1 Explain the terms solubility, saturation and super-saturation. 6.2 Describe the effect of temperature on solubility. 6.3 Explain the factors affecting nucleation 6.4 Explain Meier's theory. 6.5 Explain how super saturation may be achieved by a. Cooling. b. Evaporation. c. Salting out. 6.6 Explain the factors affecting the rate of growth of crystals. 6.7 Derive the DL for crystallization 6.8 Work out mass of seed crystals required in a batch process applying the DL Law of	Explain activities 6.1 to 6.9.	Marker & whiteboard , PC & Projector Recommended text.	Work out mass of seed crystals required in a batch process applying the DL Law of crystal growth.	Guide students to work out mass of seed crystals required in a batch process applying the DL Law of crystal growth.	Describe the effect of temperature on solubility.

	crystal growth. 6.9 Describe the techniques for producing even-sized crystals by: a. Shock cooling. b. Seeding. c. Fluid sorting.					

PROGRAMME: HIGHER NATIONAL DIPLOMA HND PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY		
COURSE TITLE: PETROLEUM REFINING PROCESSES I	**Code: PGP 324**	**CH: 2 CU: 2**
	Pre-requisite:	**Theoretical: 2 Hours/week**
Year:1 Semester:2		**Practical: 0 Hours/week**

Goal: This course is designed to enable the student acquire primary processing of crude oil in an integrated petroleum refinery.

General Objectives:

On completion of this course, the student should be able to:-

1.0 Comprehend Chemical and physical properties of refinery feedstock
2.0 Appreciate refinery processing units
3.0 Comprehend atmospheric distillation crude oil
4.0 Comprehend vacuum distillation of atmospheric residue.
5.0 Appreciate processing of crude oil for lube oil, asphalt and wax
6.0 Appreciate delayed coking process
7.0 Comprehend asphalt technology

PROGRAMME: HIGHER NATIONAL DIPLOMA HND PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (REFINING OPTION)						
COURSE TITLE: PETROLEUM REFINING PROCESSES I			**Code: PGP 324**		**CH: 2** **CU: 2** **Theoretical: 2 Hours /week** **Practical: 0 Hours/week**	
Theoretical Content				**Practical Content**		
General Objective 1.0: **Comprehend chemical and physical properties of refinery feedstock**						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1-4	1.1 Describe the chemical composition of crude oil and its products. 1.2 Describe crude oil assay. 1.3 Plot TBP and mid-point curves. 1.4 Explain properties of crude oils. 1.5 Classify crude oils. 1.6 Relate crude assay to product quality, processing requirements, and overall refinery Process Flow Diagram (PFD). 1.7 Identify crude oils suitable for lube oil and asphalt production.	Describe True Boiling Point (TBP) distillation. Carryout analysis of TBP data.	Samples of crude oil, Whiteboard, Maker, Textbooks, Calculator, Lecture note, etc.	-	-	State elemental composition of crude oil List contaminants found in crude oil Explain how crude assay gives an insight into product quality, quantity, processing requirements,

						and overall refining PFD.
General Objectives 2.0:Appreciate refinery processing units						
5 - 6	2.1 Draw a Block Flow Diagram (BFD) of a complex petroleum refining plant. 2.2 Identify primary and secondary processing units in 2. 1 above. 2.3 List out refinery products in order of increasing boiling point. 2.4 Classify refinery gases based on their areas of utilization. 2.5 List types and grades of gasoline. 2.6 Define antiknock and volatility properties of gasoline. 2.7 State the quality parameters of a gasoline. 2.8 State the factors affecting octane rating and volatility of automotive gasolines. 2.9 Explain specifications for finished petroleum fuels products.	Describe a complex petroleum refining plant with the aid of BFD. Explain the relationship among the various units in the refinery BFD.	Whiteboard, Textbooks, Lecture notes, calculator, journals, and etc	-	-	State the process units in crude oil primary processing. Mention three secondary processing units in an oil refinery.

General Objective 3.0 Comprehend atmospheric distillation of crude oil						
7 - 8	3.1 Describe dewatering/desalting, preflashing and caustic washing of crude oil before primary processing. 3.2 Describe atmospheric distillation and its products. 3.3 Appreciate the effects of direct steam on column temperature profile. 3.4 Calculate the steam requirement of topping column and side strippers. 3.5 Calculate the tray efficiency of Atmospheric Distillation Column (ADC). 3.6 Carryout materials balance for ADC. 3.7 Calculate carbon and sulphur content for ADC fractions. 3.8 Carryout heat balance for ADC. 3.9 Describe how the ADC is controlled.	Explain the pretreatment of crude oil prior to refining. Using relevant expressions, conduct calculations on ADC. Using PFD, describe how ADC is controlled.	Whiteboard, Marker, Textbooks, Calculator, Journals, etc.	-	-	Mention three crude oil fractions from topping unit. State the effect of steam on flash zone temperature Explain why crude oil is distilled in two stages Explain cold, hot and side refluxes.

General Objective 4.0 Comprehend vacuum distillation of atmospheric residue.						
9 - 10	4.1 Describe Vacuum Distillation Column (VDC) and its products (fuels and/or lubes). 4.2 Describe atmospheric distillation and its products. 4.3 Appreciate the effects of direct steam on column temperature profile. 4.4 Calculate the steam requirement of the VDC. and pump arounds. 4.5 Calculate the tray efficiency of VDC. 4.6 Carryout materials balance for VDC. 4.7 Calculate carbon and sulphur content for VDC fractions. 4.8 Carryout heat balance for VDC. 4.9 Describe how the VDC is controlled.	Describe feedstock to vacuum distillation unit. Using relevant expressions, conduct calculations on VDC. Using PFD, describe how VDC is controlled.	Whiteboard, Markers, Textbooks, Lecture notes, calculator, Journals, etc.	-	-	Mention feedstock to Vacuum Distillation Unit (VDU). State VDU products.
General Objective 5.0 Appreciate processing of crude oil for lube oils, asphalt and wax						
11 - 12	5.1 Criteria for selecting suitable crude oil for lubes and wax production. 5.2 Describe vacuum distillation of long residue for lubes production.	Describe the characteristics of crude oil suitable for lube oil, asphalt and wax production.	Whiteboard, Markers, Textbooks, Lecture	-	-	Define low, moderate and high vacuum distillation.

	5.3 Describe and evaluate the efficiency of propane de-asphalting, furfural extraction and MEK (Methylethylketone) de-waxing units of lube oil plant 5.4 Describe de-oiling and hydro-finishing of wax.	Explain vacuum distillation of long residue for lubes production.	notes, Journals, etc.			Define de-waxing and de-asphalting. Explain furfural extraction.
General Objective 6.0 Appreciate delayed coking process						
13- 14	6.1 Explain the purpose of delayed coking. 6.2 Describe the delayed coking process using PFD. 6.3 Describe the coke removal process. 6.4 Describe the properties and uses of the petroleum sponge coke (green coke) from the delayed coking. 6.5 Evaluate yield of delayed coking. 6.6 Prepare full material and energy balance of delayed coking.	Describe the coking process and its operating parameters. Explain areas of application of products from delayed coking.	Whiteboard, Duster, Textbooks, Lecture notes, journals, and etc.	-	-	Explain delayed coking process State the products from delayed coking process Describe the properties of petroleum sponge coke (green coke)

General Objective 7.0 Comprehend asphalt production technology						
15	7.1 Evaluate crude oil and other feedstock suitable for asphalt production. 7.2 Describe asphalt blowing unit. 7.3 Describe other methods of processing heavy crude oils.	Describe chemical structure of asphalt. Describe asphalt blowing. Draw the PFD for asphalt blowing.	Whiteboard, Duster, Textbooks, Lecture notes, Journals, etc.	-	-	State the characteristic of crude oil suitable for asphalt production. Explain the action of heat on asphalt.

Programme: Higher National Diploma (HND) Petroleum and Gas Processing Engineering		
Course Title: Advanced Transport Phenomena II	**Code: PGP 325**	**Credit Hour: 2** **Credit Unit: 2**
	Pre-requisite: PGP 325	**Theoretical: 2 hours/week**
Year: 1 Semester: 2		**Practical 0 : hours/week**

Course main Goal: This course is designed to enable student have general understanding of Principles of Heat and Mass Transfer

General Objectives: On the completion of the course, the student should be able to:

1.0 Appreciate advanced heat transfer problems

2.0 Appreciate unsteady state heat transfer.

3.0 Comprehend the principles of boiling and condensation.

4.0 Identify the feature of heat transfer media and equipment

5.0 Appreciate fundamentals of mass transfer systems.

6.0 Appreciate the applications of dimensionless groups

7.0 Comprehend interphase mass transfer.

8.0 Appreciate the concept of individual and overall mass transfer coefficients.

9.0 Comprehend the difference between absorption and stripping

Programme: Higher National diploma in Petroleum and Gas Processing Engineering						
Course Title: Advanced Transport Phenomena II			**Code: PGP 325**		**CH: 2 CU:2**	
Theoretical Content			**Practical Content**			
General Objective 1.0 : Appreciate Advanced Heat Transfer Problems						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1-3	1.1 Apply the graphical and numerical techniques of solving conductive heat transfer problems in two dimensional systems. 1.2 Describe detailed mechanism of convective heat transmission in both laminar and turbulent flow systems e.g. two fluids separated by plane, cylindrical and spherical walls. 1.3 Explain the analogy between energy transfer and momentum transfer in flow systems. 1.4 Apply the	Explain activities in 1.1 to 1.9	Maker & whiteboard PC & projector Textbooks	-	-	Describe the process of gas-radiation heat transfer.

	technique of dimensional analysis to convective heat transfer problems (laminar and turbulent). 1.5 Explain the NTU effective method of heat exchanger analysis and design. 1.6 Describe the process of gas-radiation heat transfer. 1.7 Solve radiative heat transfer problems involving grey surfaces and gases with and without the significant presence of other modes of heat transfer. 1.8 Explain the significance of view factor. 1.9 Solve momentum transfer problems using analytical analogue technique as appropriate.					

General Objective 2.0: Appreciate Unsteady State Heat Transfer						
4	2.1 Explain unsteady state heat transfer theory to the heating and cooling of stirred tanks using isothermal and non-isothermal heating media. 2.2 Derive Time - Temperature relationships for tanks heated or cooled by internal coils. 2.3 Derive Time - Temperature relationships for tanks heated or cooled by circulation through external heat exchanger.	Compare the sketches of time-temperature relationships for tanks heated or cooled by internal coil to that cooled or heated by circulation through external heat exchange.	Maker & whiteboard PC & projector Textbooks	-	-	Derive Time - Temperature relationships for tanks heated or cooled by internal coils.
General Objective 3.0:Comprehend the Principles of Boiling and Condensation						
5-7	3.1 Describe modes of boiling as pool and convective. 3.2 Describe the regimes of pool boiling showing heat flux as a function of	Explain boiling phenomenon in chemical processes. Explain the significance of burn out point.	Maker & whiteboard PC & projector Textbooks	-	-	State the significance of burn out point

	temperature difference between the liquid and heating surfaces. 3.3 Explain the significance of various types of boiling in terms of heat transfer coefficient values. 3.4 Explain the significance of burn out point. 3.5 Explain the effects of surface roughness and wettability on boiling heat transfers. 3.6 Explain the process of condensation. 3.7 Describe the mechanism of heat transfer in film type and drop-wise condensation of vapours. 3.8 Explain the difference between drop wise and film type condensation and its effect on the values of convective heat transfer coefficient.	Explain the concepts of condensation				

	3.9 Calculate film coefficients using the Nusselt equation for film type condensation on a a. Vertical surface b. Inclined plane c. Horizontal plane. 3.10 Explain how the Nusselt equation can be modified to allow a) Sub-cooling of condensate b) Non-condensate gases c) Vapour velocity and turbulence d) Flooding. 3.11 Explain how design procedures need to be modified when dealing with mixtures of condensable gases.					
General Objective: 4.0:Identify the Feature of Heat Transfer Media and Equipment						
8	4.1 Describe heat	Explain the operation	Maker &	-	-	Explain

	transfer media. 4.2 Describe heat transfer equipment e.g. exchangers, heaters, coolers, condensers, reboilers, evaporators, etc. 4.3 Explain radiant heat transmission and resistance concepts.	of heat exchanger, condenser and reboiler.	whiteboard PC & projector Textbooks			radiant heat transmission and resistance concepts.
General Objective 5.0: Appreciate Fundamentals Of Mass Transfer Systems.						
9-10	5.1 Describe the following mechanism of diffusion: a. Molecular diffusion. b. Eddy diffusion 5.2 Explain the white man two-film theory. 5.3 Explain how the resistance to mass transfers lies in a film adjacent to phase interface.	Demonstrate molecular diffusion by spraying dust particles over water in a basin. Explain from their understanding the Whiteman two film theory	Maker & whiteboard PC & projector Textbooks	-	-	Explain the white man two-film theory.
General Objective 6.0: Appreciate The Applications Of Dimensionless Groups.						
11	6.1 Explain skin friction in flow of gases through porous solids.	Ensure that students solve problems using dimensionless groups as applied in mass	Maker & whiteboard PC & projector	-	-	Explain skin friction in flow of gases through porous

	6.2 Draw analogy between heat transfer and mass transfer.	and heat transfer.	Textbooks			solids.
General Objective 7.0: Comprehend interphase mass transfer.						
12	7.1 Explain resistance relationship. 7.2 Explain the following:- a. Gas-film control processes; b. Liquid-film control processes; c. Reaction control processes. 7.3 Explain the following:- a. Number of transfer units; b. Equilibrium curves; c. Operating curves. 7.4 Evaluate stages in counter-current processes. 7.5 Describe interphase mass transfer equipment.	Explain the gas-film control processes, the liquid-film control processes and the reaction control processes as a test of their understanding of the lecture Sketch the mass transfer control process diagram on the chalkboard.	Maker & whiteboard PC & projector Textbooks	-	-	Describe interphase mass transfer equipment.

General Objective 8.0:Appreciate the concept of individual and overall mass transfer coefficients						
13	8.1 Evaluate individual mass transfer coefficients. 8.2 Evaluate overall mass transfer coefficients. 8.3 Carry out material balances for: a. Co-current b. Counter-current systems for differential and stage-wise contacts. 8.4 Carry out material balances for cascades.	Explain activities in 8.1 to 8.4	Maker & whiteboard PC & projector Textbooks	-	-	Explain individual mass transfer coefficients.
General Objective 9.0: Comprehend the Difference between Absorption And Stripping						
14-15	9.1 Define absorption factor. 9.2 Define stripping factor. 9.3 Describe absorption and stripping equipment	Explain activities in 9.1 to 9.3	Maker & whiteboard PC & projector Textbooks	-	-	Describe absorption and stripping equipment

Programme: Higher National Diploma (HND) Petroleum and Gas Processing Engineering		
Course Title: Advanced Petrochemical Process Technology I	**Code: PGP 326**	**Credit Hour: 2** **Credit Unit: 2**
	Pre-requisite:	**Theoretical: 2 hours/week**
Year: 1 Semester: 2		**Practical 0 : hours/week**

Goal: This course is designed to provide the students with basic knowledge of petrochemical feedstock and their derivatives

General Objectives: On the completion of the course, the student should be able to:

1.0 Appreciate the technology for olefin production

2.0 Appreciate C_4 and C_5 olefins production from fluid catalytic cracking and steam cracking technologies

3.0 Appreciate the technology for the production of ethylene and its derivatives

4.0 Appreciate the technology for the production of propylene and its derivatives

5.0 Appreciate the basic knowledge on the production of C_4 and C_5 compounds and its derivatives

Programme: Higher National Diploma (HND)Petroleum and Gas Processing Engineering (Petrochemical and Gas Processing Option)						
Course Title: Advanced Petrochemical Process Technology I			**Code: 326**		**CH: 2 CU: 2**	
Theoretical Content: 2			**Practical Content:**			
General Objective 1.0 : Appreciate the Technology for Olefin Production						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1-3	1.1 Define olefins and state its relevance in the petrochemical industry 1.2 List products obtainable from olefins 1.3 List feedstock used for olefins production 1.4 Describe common steam cracking technologies for olefins production 1.5 Describe Amine process technology for natural gas sweetening 1.6 Describe steam cracking process technology under the	Explain the relevance of olefins to petrochemical industry Illustrate Amine process technology with the aid of process flow diagram Illustrate Naphtha cracking technology with the aid of process flow diagram Explain the effect of operating variables in steam cracking	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	Explain Olefins and its relevance in petrochemical industry. List the feedback and products of Olefins. Explain the stages involve in steam cracking process. Explain the operating variables associated

	following stages: (a) Hot section process (b) Gas compression and dehydration (c) Cold section process (d) Demethaniser unit (e) Deethanizer unit (f) Acetylene separation (g) Ethylene separation (h) Depropaniser (i) $C_3^{=}$Hydrogenation (j) Debutanizer (k) Ethylene refrigeration process 1.7 List and discuss operating variable associated with steam cracking process 1.8 Explain thermal	process Explain thermal cracking with the aid of process flow diagram Explain emerging technologies for olefin production.				with steam cracking. Explain coke formation and decoking process in thermal cracking. Explain the following: a. Oxidative coupling of methane. b. integrated process for ethylene from methane. c. dehydrogenation of paraffin. d. methanol to olefins (MTO technology.

	cracking process technology 1.9 Explain coke formation and decoking process in thermal cracking 1.10 Give the process description of the following emerging technologies for olefins production: (a) Oxidative coupling of methane (b) Integrated process for ethylene from methane (c) Dehydrogenation of paraffin’s (d) Methanol to olefins technology (MTO) (e) Deep catalytic cracking technology (DCC) (f) Olefins conversion technology					

	(OCT) (g) Catalytic pyrolysis process					
General Objective 2.0: Appreciate C_4 and C_5 olefins production from fluid catalytic cracking and steam cracking technologies						
4-6	2.1 Identify the sources of C_4 and C_5 hydrocarbon in oil refining process 2.2 Present products distribution of Fluid Catalytic Cracking (FCC) process technology 2.3 Describe evolution of FCC technology based on catalyst development 2.4 Give brief description of FCC technologies developed by various Licensors 2.5 Give detail process description of a typical FCC 2.6 State process conditions and catalyst system used in FCC	Present a chart for FCC product distribution Explain FCC technology with the aid of process flow diagram Explain the development of FCC technology Mention major FCC Licensors State the relevance of FCC operating conditions Depict FCC reactor design with the aid of a well labelled diagram	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	--	-	Explain FCC process. List major licensors in FCC State the process conditions and catalyst used in FCC State the importance of oxygenates in gasoline production

	2.7 Sketch a typical FCC reactor with riser 2.8 Give typical composition of LPG from FCC process 2.9 Discuss C_4 cut processing from steam cracker and FCC 2.10 Describe sequence of C_4 extraction 2.11 Identify oxygenates in refinery process 2.12 State the importance of oxygenate in gasoline production 2.13 Describe Methyl Tertiary Butyl Ether (MTBE) process technology 2.14 Describe Tertiary Amyl Methyl Ether (TAME) process technology 2.15 Compare 2.13	State the importance of LPG Explain the recovery of C4 cut from steam cracking process Mention the importance of oxygenate Explain the application of MTBE Explain the application of TAME				

	with 2.14 above. 2.16 Give process description of C_5 stream upgrade for recovery of C_5 chemicals.					
General Objective 3.0: Appreciate the Technology for the Production of Ethylene and Its Derivatives						
7-9	3.1 Explain the relevance of Ethylene to the petrochemical industry 3.2 Describe the main routes for ethylene production 3.3 List the chemicals obtainable from ethylene 3.4 List the common feedstock for ethylene production 3.5 State the relevance of ethylene oxide as a derivative of ethylene 3.6 List important chemicals obtainable from ethylene oxide	Mention the applications of ethylene Present with the aid of chart the product profile of ethylene Mention major feedstock for ethylene production Mention the importance of ethylene oxide Present with the aid of process flow diagram the production of ethylene oxide Mention the importance of mono	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	Explain the relevance of ethylene in petrochemical industry. Distinguish between chlorohydrin and direct oxidative process for ethylene oxide production. Explain the importance of mono ethylene glycol (MEC) to petrochemical industry. List important chemical derived from acetaldehyde.

	3.7 Distinguish between chlorohydrin process and direct oxidation process for ethylene oxide production 3.8 State the process conditions and catalyst system used in each ethylene oxide production technology 3.9 State the hazards associated with handling ethylene oxide 3.10 Explain the importance of monoethylene glycol (MEG) 3.11 Explain process description for the production of MEG 3.12 State the importance of vinyl chloride 3.13 State the routes for the production of vinyl chloride	ethylene glycol Present with the aid of process flow diagram the production of mono ethylene glycol Mention the importance of vinyl chloride Present with the aid of process flow diagram the production of vinyl chloride Mention the importance of vinyl acetate Present with the aid of process flow diagram the production of vinyl acetate Mention the importance of acetaldehyde				

	3.14 Explain process description for the production of vinyl chloride by ox chlorination of ethylene 3.15 State the importance of vinyl acetate 3.16 List out important chemicals obtainable from vinyl acetate 3.17 Explain process description for the production of vinyl acetate by vapor phase process 3.18 State the importance of acetaldehyde 3.19 List out important chemicals obtainable from acetaldehyde 3.20 Explain process description for the production of acetaldehyde by liquid phase oxidation of ethylene	Present with the aid of process flow diagram the production of acetaldehyde Mention the importance of ethanol Present with the aid of process flow diagram the production of ethanol Mention the importance of acetate anhydride Present with the aid of process flow diagram the production of acetate anhydride				

	3.21 State the importance of ethanol 3.22 List out important chemicals obtainable from ethanol 3.23 Explain process description for ethanol production from catalytic recycle hydration of ethylene 3.24 State the importance of aceticanhydride 3.25 List out important chemicals obtainable from acetic anhydride 3.26 Explain process description for acetic anhydride production from acetaldehyde route 3.27 State the importance of ethanol amine 3.28 List out important					

	chemicals obtainable from ethanol amine 3.29 Explain process description for ethanol amine production from ethylene oxide. 3.30 List other derivatives of ethylene and state their major application.					
General Objectives 4.0: Appreciate The Technology For The Production Of Propylene And Its Derivatives						
10-11	4.1 Explain the relevance of propylene to the petrochemical industry 4.2 List the chemical obtainable from propylene 4.3 State technologies for the production of propylene 4.4 Explain detailed description of propylene recovery from FCC process	Mention the applications of propylene Present with the aid of chart the product profile of propylene Mention commercial technologies for propylene production Illustrate with the aid of process flow diagram the	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	Explain the relevance of propylene of petrochemical industry. Explain with the aid of a diagram Metathesis. Explain the hydration of propylene oxide to propylene glycol.

	4.5 State typical operating condition in FCC, Deep Catalytic Cracking (DCC) and Steam cracking 4.6 Describe Metathesis process technology 4.7 List products obtained from Metathesis process 4.8 Describe catalytic dehydrogenation of light paraffin 4.9 Describe Methanolto Propylene (MTP) process technology 4.10 Explain the application of propylene oxide 4.11 State the commercial route for propylene oxide production 4.12 Explain process description of propylene oxide	recovery of propylene from FCC process Describe Metathesis technology with the aid of process flow diagram Explain dehydrogenation of light paraffin Describe MTP process with the aid of process flow diagram Mention the importance of propylene oxide With the aid of process flow diagram describe chlorohydrin technology for production of propylene oxide				

	production from chlorohydrin route 4.13 Mention the application of propylene glycol 4.14 Explain process description of propylene glycol production by hydration of propylene oxide solution 4.15 Explain the application of isopropyl alcohol 4.16 State commercial route for the production of isopropyl alcohol 4.17 Explain process description for isopropyl alcohol production from direct hydration of propylene 4.18 Mention the application of acetone in petrochemical industry	With the aid of process flow diagram describe hydration for propylene oxide to propylene glycol With the aid of process flow diagram describe hydration of propylene oxide to propylene glycol Mention the importance of isopropyl alcohol With the aid of process flow diagram describe isopropyl alcohol Mention the importance of acetone With the aid of process flow diagram describe acetone from				

	4.19 State the commercial route for the production acetone 4.20 Explain process description for the production of acetone from isopropyl alcohol dehydrogenation process 4.21 Mention the application of acrylonitrile in petrochemical industry 4.22 State commercial route for the production acrylonitrile 4.23 Explain process description for the production of acrylonitrile by ammoxidation of propylene 4.24 Mention the application of cumene in petrochemical	isopropyl alcohol Mention the importance of acrylonitrile With the aid of process flow diagram describe ammoxidation of propylene to acrylonitrile Mention the importance of cumene With the aid of process flow diagram describe propylene alkylation for cumene production				

	industry 4.25 Explain process description for the production of cumene from propylene alkylation.					
General Objective 5.0 Appreciate the basic knowledge on the production of C_4 and C_5 compounds and its derivatives						
12-13	5.1 Describe the product profile of C_4 olefins 5.2 State typical composition of C_4 hydrocarbon feed 5.3 Describe the product profile of C_5 olefins 5.4 State typical composition of C_5 hydrocarbon feed	With the aid of a chart present the product profile of C4 olefins With the aid of a chart present the product profile of C5 olefins List the typical constituents of C4	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	Describe the products obtain from c4 and c5 olefins. Explain the importance of Butadiene. State the applications of: • 1 –butanes • n- butanes

	5.5 Explain the application of butadiene in petrochemical industry 5.6 Explain commercial routes for the production butadiene 5.7 Explain process description for the production of butadiene by catalytic dehydrogenation of butanes 5.8 Explain the application of 1, 4-butanediol in petrochemical industry 5.9 Describe commercial routes for the production 1, 4-butanediol 5.10 Give process description for the production of 1, 4-butanediol by maleic anhydride	hydrocarbon feed List the typical constituents of C5 hydrocarbon feed Mention the importance of butadiene With the aid of process flow diagram describe catalytic dehydrogenation of butanes to butadiene Mention the importance of 1, 4-butanediol in petrochemical industry With the aid of process flow diagram describe 1, 4-butanediol production from maleic anhydride route				• isobutylene • n – butane • octane • chloroprene • cyclopentadienyl • piperylene

	route 5.11 Mention the application of isoprene in petrochemical industry 5.12 State commercial routes for the production isoprene 5.13 Explain process description for isoprene extraction process 5.14 Explain the application of the following C_4/C_5 hydrocarbons: • 1-butenes • n-butanes • isobutylene • n-butane • octane • chloroprene • cyclopentadiene • 1,3 – Pentadiene	Mention the importance isoprene in petrochemical industry With the aid of process flow diagram describe isoprene extraction process				

Programme: Higher National Diploma in Petroleum and Gas Processing Engineering		
Course Title: Advanced Polymer Science and Technology	**Code: PGP 327**	**Credit Hour: 2** **Credit Unit: 2**
	Pre-requisite:	**Theoretical: 2 hours/week**
Year: 1 Semester: 2		**Practical 0 : hours/week**

Course main Goal: This course is designed to enable student have general understanding of polymer processing technology

General Objectives: On the completion of the course, the student should be able to:

1.0 Outline the classes of polymers and their raw material sources.
2.0 Comprehend the chemistry of polymerization processes.
3.0 Comprehend principles of polymer manufacture**.**
4.0 Comprehend polymer materials production (synthetic and natural).
5.0 Comprehend different polymer properties and testing
6.0 Comprehend different polymer properties and testing

7.0 Comprehend how to modify polymer properties.

Programme: Higher National Diploma in Petroleum and Gas Processing Engineering (Petrochemical and Gas Processing Option)						
Course Title: Advanced Polymer Science and Technology			**Code: PGP 327**		**CH:2**	**CU:2**
Theoretical Content			**Practical Content**			
General Objective 1.0: Outline the classes of polymers and their raw material sources.						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1	1.1 Classify polymers 1.2 List sources of polymeric raw materials. 1.3 Explain Natural gas and Crude oil as sources polymeric raw materials	Explain the ways through which polymers are classified Explain natural and synthetic sources of polymer Mention the final polymeric raw materials obtainable from natural gas and crude oil and their respective polymers.	Laptop, Multimedia Projector, Marker and Recommended text	-	-	Define polymers. Explain sources of polymers.
General Objective 2.0: Comprehend the chemistry of polymerization processes						
2-3	2.1 Explain the type of chemical bond involve in polymer	Explain the mechanisms of reactions in addition	Recommended textbooks,	-	-	Explain the type of chemical bond

	formation 2.2 Explain polymer structure 2.3 Explain addition polymerization, condensation polymerization, co-polymerization and vulcanization reactions 2.4 Explain the mechanisms of the reactions in (2.1) above.	polymerization and condensation polymerization	internet services, etc.			involve in polymer formation
General Objective 3.0: Comprehend principles of polymer Production.						
4-5	3.1 Explain the various classes of polymerization process including solution polymerization, suspension polymerization, emulsion polymerization, vulcanization, compounding and reinforcement. 3.2 Explain the effect of heat and mass transfer on the various processes in (3.1)	Ensure that students understand the fundamentals of polymer manufacturing process.	Laptop, Multimedia Projector, Marker and Recommended text	-	-	Describe the processes involved in polymer production. Describe

	above. 3.3 Explain the basic principles of design of polymer reactors					design condition for polymer production system.
General Objective 4.0: Comprehend polymer materials production (synthetic and natural).						
6-7	4.1 Describe the manufacture of natural resin latex. 4.2 Describe process of production of polymer materials from : a. Natural Gas b. Crude oil 4.3 Describe the production of thermoplastics, polyvinyl, nylons, and acrylic and phenoxy resins. 4.4 Explain the production of thermos setting polymers of phenol, formaldehydepolyester, amino and epoxy resins	Compare the manufacture of natural resin late to the production of synthetic polymers e.g. polyester Mention the polymer materials obtainable from natural gas and	Laptop, Multimedia Projector, Marker and Recommended text	-	-	Explain the production of various polymers.
General objective 5.0: Comprehend the various methods of processing polymers						
8-9	5.1 Mention some unit operations used in polymer processing 5.2 Describe mastication,	Assess the students' understanding of polymer processing methods.	Laptop, Multimedia Projector, Marker and	-	-	Mention some unit operations used in polymer

	mixing, extrusion, calendaring, moulding, thermo-forming and sintering Processes. 5.3 Explain the purposes of the various processing methods in (5.2) above.	Give examples of products of the methods discussed in (5.2).	Recommended text			processing
General Objective 6.0 : Comprehend different polymer properties and testing						
10-11	6.1 Explain rheology of polymers. 6.2 Describe the physical properties of polymers including mechanical, electrical and chemical resistance. 6.3 Describe the testing of basic polymer properties.	Assess the students understanding of polymer products properties and quality standard	Laptop, Multimedia Projector, Marker and Recommended text	-	-	Explain why testing of basic polymer properties is importance.
General Objective 7.0: Comprehend how to modify polymer properties.						
12-15	7.1Explain the purpose of various additives including carbon black and non-carbon black, fillers, plasticizers, extenders, softeners and antioxidants. 7.2 Describe the addition	Give examples of typical polymer additives and their effects on polymer products quality.	Laptop, Multimedia Projector, Marker and Recommended text	-	-	Explain modification of polymer properties

	processes required to attain the desired properties.					

PROGRAMME: HIGHER NATIONAL DIPLOMA HND PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY		
COURSE TITLE: Gas Processing Laboratory Technique I	**Code: GPT 321**	**Credit Hour: 3** **Credit Unit: 2**
	Pre-requisite:	**Theoretical: 0 hours/week**
Year: 1 Semester: 2		**Practical: 3 hours/week**

Goal: This course is designed to enable students acquire basic practical knowledge and skills required in gas production and processing.

General Objectives: On completion of the course, the students should be able to:

1.0 Carry out basic operations in natural gas production
2.0 Identify crude oil and natural gas production facilities
3.0 Perform computer simulation on gas production, conditioning, and processing
4.0 Appreciate dew point temperature determination of a gas
5.0 Appreciate natural gas processing techniques
6.0 Identify well-head completion and well-head equipment
7.0 Recognize the internal components and working principles of Oil-Gas Separator

<table>
<tr><td colspan="7">Programme: Higher National diploma in Gas Processing Engineering Technology.</td></tr>
<tr><td colspan="3">Course Title: Gas Processing Laboratory Technique I</td><td colspan="3">Code: GPT 321</td><td>CH: 3
CU:2</td></tr>
<tr><td colspan="3">Theoretical Content</td><td colspan="4">Practical Content</td></tr>
<tr><td colspan="7">Goal: This course is designed to enable students acquire basic practical knowledge and skills required in gas production and processing</td></tr>
<tr><td colspan="7">General Objective 1.0: Carry out basic operations in crude oil and natural gas production</td></tr>
<tr><td>Week</td><td>Specific Learning Outcomes</td><td>Teacher’s Activities</td><td>Resources</td><td>Specific Learning Outcomes</td><td>Teacher’s Activities</td><td>Evaluation</td></tr>
<tr><td>1-2</td><td>-</td><td>-</td><td>Practical manual,
Production rig plant</td><td>1.1 Demonstrate safety procedures in petroleum production
1.2 Identify drilling equipment
1.3 Identify production equipment
1.4 Identify production rate measurement</td><td>Guide students in the: Demonstration of 1.1
Identify 1.2 to 1.4
Demonstration of rig plant operations</td><td>Explain the rig plant operations</td></tr>
<tr><td colspan="7">General Objective 2.0: Identify crude oil and natural gas production facilities</td></tr>
<tr><td>3-4</td><td></td><td></td><td>Practical manual
Flow station</td><td>2.1 Identify Christmas tree
2.2 Identify three phase separators
2.3 Differentiate pipelines using color codes
2.4 Identify high, medium and low-pressure gas pipelines
2.5 Identify flow meters and flow</td><td>Guide students to: Identify 2.1 to 2.5
Show flow station</td><td>Explain the operation of the flow station</td></tr>
</table>

				control valves	operations	
General Objective 3.0: Perform computer simulation on gas production, conditioning, and processing						
5-6	-	-	Practical manual Gas simulator	3.1 Perform checks on electrical connections on the gas simulator 3.2 Perform login procedure 3.3 Simulate process units 3.4 Perform logging operations 3.5 Shutdown the simulator	Guide students to demonstrate the operation of the petroleum production and processing simulator	Explain how to use the simulator
General Objective 4.0: Determine dew point temperature of a gas						
7-8	-	-	Practical manual, Glass cup, water, thermometer and ice block	4.1 Take sample of the gas 4.2 Describe the experimental procedure 4.3 Determine dew point temperature of a gas 4.4 Interpret the result	Guide the students to perform the experiment	Explain the modules of the practicals
General Objective 5.0: Demonstrate natural gas processing techniques						
9-11	-	-	Practical manual Gas simulator	5.1 Perform checks on electrical connections of the gas simulator 5.2 Perform login procedure 5.3 Identify and	Guide students to demonstrate the operation and control of gas simulator (processing).	Explain how to identify abnormal situation in gas processing units

				simulate process units 5.4 Perform logging operations 5.5 Shutdown the simulator		
General Objective 6.0: Identify well-head completion and well-head equipment						
12-13	-	-	Practical Manual Drilling Field Casing Head Casing Spool Tubing Spool Christmas Tree	6.1 Demonstrate well-head drilling 6.2 Identify casing materials 6.3 Perform tubing operations 6.4 Demonstrate well-head installation	Guide students to demonstrate drilling operations and installation of well-head	Describe well-head installation
General Objective 7.0: Visualize internal components and working principles of Oil-Gas Separator						
14-15	-	-	Practical manual Cut-away separator model	7.1 Identify oil-gas separator 7.2 Identify the internal components of an oil-gas separator 7.3 Demonstrate the working principles of oil-gas separator (two phase, three phase)	Guide students to demonstrate how oil-gas separator works	Describe oil-gas separator.

PROGRAMME: HIGHER NATIONAL DIPLOMA IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (GAS PROCESSING OPTION)		
COURSE TITLE: GAS PRODUCTION TECHNOLOGY 1	**Code:** GPT 322	**Credit Hour: 4** **Credit Unit: 2**
	Pre-requisite:	**Theoretical: 1 Hours/week**
Year: 2 Semester: 1		**Practical: 3 Hours/week**

Goal: This course is designed to acquaint students with knowledge and skills of Natural Gas Processing Technology.

General Objectives: On completion of this course, the student should be able to:

1.0 Appreciate natural gas sources and types of natural gasses
2.0 Appreciate hydrocarbon fluid mechanics and concepts of phase behaviour of Hydrocarbon system
3.0 Comprehend material balance in gas production
4.0 Appreciate gas well test procedures
5.0 Comprehend retrograde phenomenon and gas condensate vapour-liquid equilibrium
6.0 Appreciate the application of basic thermodynamic concepts innatural gas processing
7.0 Appreciate treatment of natural gas

PROGRAMME: HIGHER NATIONAL DIPLOMA IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (GAS PROCESSING OPTION)						
COURSE TITLE: GAS PRODUCTION TECHNOLOGY I				**Code: GPT 322**	**CH: 4**	**CU:2**
Theoretical Content				**Practical Content = 0 hour**		
8.0 **General Objectives 1.0:** Appreciate natural gas sources and types of natural gasses						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1	1.1 Enumerate sources of natural gas 1.2 Explain types of natural gas 1.3State the composition of natural gas	Explain activities in 1.1 to 1.3	White board, recommended textbooks, lecture notes and related journals	-	-	State typical composition of natural gas
General Objective 2.0: Appreciate hydrocarbon fluid mechanics and concepts of phase behaviour of Hydrocarbon system						
2 – 5	2.1 Describe the peculiar behaviour of hydrocarbon fluids: permeability, porosity, saturation etc 2.2 Explain gas solubility and gas/vapour – liquid equilibrium 2.3 Analyze qualitative phase	Explain activities in 2.1 to 2.3	White board, recommended textbooks, lecture notes and related journals	-	-	Explain gas solubility and gas/vapour equilibrium

	behaviour; P-V-T plots, vapour pressure, critical and pseudo-critical.					
General Objective 3.0: Comprehend material balance in gas production						
5 - 7	3.1 Describe the reservoir derive mechanism 3.2 Develop from first principles the material balance equation 3.3 Apply material balance equation to analyze a reservoir 3.4 Evaluate gas reserve using relevant equation 3.5 Estimate reservoir content using geological data 3.6 Evaluate original gas-in-place in the reservoir 3.7 Evaluate gas produce from the reservoir	Explain activities in 3.1 to 3.10	White board, recommended textbooks, lecture notes and related journals	-	-	Estimate reservoir content using geological data

	3.8 Evaluate final gas-in-place at abandonment 3.9 Evaluate pressure draw-down and build-up. 3.10 Describe the equipment used in gas operations					
General Objective 4.0: Appreciate gas well test procedures						
8	4.1 Explain the term well testing 4.2 Enumerate different types of well testing in practice	Explain activities in 4.1 to 4.2	White board, recommended textbooks, lecture notes and related journals	-	-	List different types of well testing procedures
General Objective 5.0: Comprehend retrograde phenomenon and gas condensate vapour-liquid equilibrium						
9-11	5.1Explain retrograde phenomenon in hydrocarbon system 5.2 Distinguish between liquid retrograde and gas retrograde systems vapour-liquid equilibrium in	Explain activities in 5.1 to 5.3	White board, recommended textbooks, lecture notes and related journals	-	-	Explain retrograde phenomenon in hydrocarbon system

	hydrocarbon systems 5.3 Differentiate between state and phase					
General Objectives 6.0: Appreciate the application of basic thermodynamic concepts on natural gas processing						
11-13	**6.1** Review the basic thermodynamic laws **6.2** Explain basic thermodynamic accounting of mass and energy 6.1 Explain enthalpy and entropy application in gas processing 6.2 Compare ideal and real situations in gas processing thermodynamic variables	Explain activities in 6.1 to 6.4	White board, recommended textbooks, lecture notes and related journals	-	-	Differentiate ideal and real gas in gas processing
General Objectives 7.0: Appreciate treatment of natural gas						
14-	**7.1** State the purpose of gas	Explain the activities in 7.1	White board,	-	-	List purification methods in gas

15	treatment 7.2 Describe purification methods and processes in gas treatment 7.3 Describe the following treatment facilities, stating their relevance:- - inlet manifold - separators - scribers - dehydrators or driers - heaters - compressors - coolers - chemical tanks	to 7.3	recommended textbooks, lecture notes and related journals			treatment

PROGRAMME: HIGHER NATIONAL DIPLOMA (HND) IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (PETROCHEMICAL AND POLYMER OPTION)		
COURSE TITLE: PETROCHEMICAL SYNTHESIS LABORATORY TECHNIQUES	**Code: Code: PPT 321**	**Credit Hour: 2** **Credit Unit:2**
	Pre-requisite:	**Theoretical: 0 hours/week**
Year: 1 Semester: 1		**Practical: 2 hours/week**

Goal: This course is designed to acquaint the students with the practical knowledge of Petrochemical Synthesis

General Objectives: On completion of the course, the student should be able to:

1.0 Perform laboratory preparation of Nitrobenzene

2.0 Perform laboratory preparation of m-Dinitrobenzene

3.0 Perform laboratory preparation of Acetophenone

4.0 Perform laboratory preparation of Methylbenzoate

5.0 Perform laboratory preparation of Methyl m-Nitrobenzoate from Methylbenzoate

6.0 Carryout Free Radical Polymerization of a monomer

7.0 Carryout Polymerization of Styrene

PROGRAMME: HIGHER NATIONAL DIPLOMA (HND) IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (PETROCHEMICAL AND POLYMER OPTION)						
COURSE TITLE: PETROCHEMICAL SYNTHESIS LABORATORY TECHNIQUES					**Code: PPT 321**	**CH: 2** **CU:2**
Theoretical Content				**Practical Content**		
General Objective1.0: Perform laboratory preparation of Nitrobenzene						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1-2			Practical manual, reagents, fume cupboard, material safety data sheet, PPE, etc.	1.1 List the chemicals used in the preparation of nitrobenzene. 1.2 Explain the procedure used in the preparation of nitrobenzene. 1.3 Carryout the preparation of nitrobenzene. 1.4 State the uses of Nitrobenzene.	Provide the reagents/chemicals to be used. Guide the students to carry out the production of Nitrobenzene.	State the major reagents used in the synthesis of nitrobenzene
General Objective 2.0: Perform laboratory preparation of m-Dinitrobenzene						
3-4			Practical manual, reagents, fume cupboard, material safety data sheet, PPE, etc.	2.1 List the chemicals used in the preparation of m-dinitrobenzene. 2.2 State the procedure used in the preparation of m-dinitrobenzene. 2.3 Mention the catalyst(s) used in the preparation of m-dinitrobenzene. 2.4 Mention the solvent(s) used for the recrystallization of m-dinitrobenzene. 2.5 State the uses of m-dinitrobenzene.	Provide the reagents/chemicals to be used. Guide the students to carry out the production of m-Dinitrobenzene.	Mention the catalyst(s) used in the preparation of m-dinitrobenzene. Mention the solvent(s) used in m-dinitrobenzene recrystallization.

General Objectives 3.0: Perform laboratory preparation of Acetophenone						
5-6			Practical manual, reagents, fume cupboard, material safety data sheet, PPE, etc.	3.1 List the chemicals used in preparing acetophenone. 3.2 Describe the procedure for preparing acetophenone from benzene. 3.3 Carryout the preparation of acetophenone. 3.4 Describe how acetophenone can be prepared from various sources. 3.5 State the uses of acetophenone.	Provide the reagents/chemicals to be used. Guide the students to carry out the preparation of acetophenone.	Describe the procedure for preparing acetophenone from benzene State the uses of acetophenone
General Objective 4.0:Perform laboratory preparation of Methylbenzoate						
7-8	.		Practical manual, reagents, fume cupboard, material safety data sheet, PPE, etc.	4.1 State the procedure for the preparation of methyl benzoate from benzene. 4.2 State the mechanism for nitration of methyl benzoate. 4.3 Explain nitrating mixture in the preparation of meta nitrobenzoic acid. 4.4 State the formula for methyl benzoate. 4.5 List the uses of methyl benzoate.	Provide the reagents/chemicals to be used. Guide the students to carry out the production of methyl benzoate.	Explain the mechanism for nitration of methyl benzoate. List the uses of methyl benzoate.
General Objective 5.0: Perform laboratory preparation of Methyl m-Nitrobenzoate from Methylbenzoate						
9-10	.		Practical manual, reagents, fume cupboard, material safety data sheet, PPE, etc.	5.1 State the purpose of the nitration of methyl benzoate. 5.2 Prepare the methyl m-Nitrobenzoate. 5.3 State the mechanism for nitration of methyl benzoate. 5.4 State the role of sulphuric acid in the preparation of methyl m-	Provide the reagents/chemicals to be used. Guide the students to carry out the preparation of Methyl m-Nitrobenzoate.	State uses of m-nitrobenzoate.

				nitrobenzene. 5.5 Confirm that the collected crystal is methyl m-nitrobenzoate.		
General Objectives 6.0: Carryout Free Radical Polymerization of a monomer						
11-12				6.1 Mention the initiator efficiency in chain initiation step of free radical polymerization. 6.2 List the free radical polymerization reaction initiators 6.3 State the purpose of an initiator in polymerization reactions. 6.4 Explain the steps of chain initiation for free radical polymerization. 6.5 State the catalyst(s) used for free radical polymerization reaction. 6.6 Carryout polymerization reaction of a monomer using free radical as initiator.	Provide the reagents/chemicals to be used. Guide the students to carry out the experiment.	State the importance of imitator in free radical polymerization
General Objective 7.0: Carryout Polymerization of Styrene						
13-15			Practical manual, reagents, fume cupboard, material safety data sheet, PPE, etc.	7.1 Describe methods of polymerization. 7.2 Describe the polymerization of styrene. 7.3 Prepare polystyrene from styrene. 7.4 List the uses of styrene and polystyrene.	Provide the reagents/chemicals to be used. Guide the students to carry out the experiment.	State the uses of styrene and polystyrene.

YEAR 2 SEMESTER 1

Programme: Higher National diploma in Petroleum and Gas Processing Engineering (Petrochemical and Gas Processing Option).		
Course Title: Advanced Gas Processing Technology I	**Code: PGP 411**	**Credit Hour: 2** **Credit Unit:2**
	Pre-requisite:	**Theoretical: 2 hours/week**
Year: 2 Semester: 1		**Practical 0 : hours/week**

Goal: This course is to acquaint students with the knowledge in gas processing technology

General Objectives: On the completion of the course, students should be able to:

1.0 Appreciate natural gas technology

2.0 Comprehend gas processing technologies

3.0 Comprehend the fundamentals of gas treating, gas dehydration, hydrocarbon recovery, nitrogen rejection and trace components recovery

4.0 Appreciate the principles of liquids processing.

5.0 Appreciate the Sulphur Recovery Process.

<table>
<tr><td colspan="7">Programme: Higher National Diploma (HND) in Petroleum and Gas Processing Engineering Technology (Petrochemical and Gas Processing option)</td></tr>
<tr><td colspan="3">Course Title: Advanced Gas Processing Technology I</td><td colspan="2">Code: PGP 411</td><td colspan="2">CH: 2 CU: 2</td></tr>
<tr><td colspan="3">Theoretical Content</td><td colspan="4">Practical Content</td></tr>
<tr><td colspan="7">General Objective 1.0 :Appreciate Natural Gas Technology</td></tr>
<tr><td>Week</td><td>Specific Learning Outcomes</td><td>Teacher’s Activities</td><td>Resources</td><td>Specific Learning Outcomes</td><td>Teacher’s Activities</td><td>Evaluation</td></tr>
<tr><td>1-2</td><td>1.1 Define the term natural gas.
1.2 Explain the development of natural gas.
1.3 Mention sources of natural gas.
1.4 Explain the composition of natural gas.
1.5 Describe the Physical and Chemical properties of Natural Gas
1.6 State the classification of natural gas
1.7.Explain the processing of natural gas.
1.8.List the major products of natural gas.</td><td>Describe the processes involved in natural gas formation in a source rock.

Enumerate the sources of natural gas.

Explain the composition and classification of natural gas.

.</td><td>Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.</td><td>-</td><td>-</td><td>State the classification and properties of natural gas.

List major products of natural gas.</td></tr>
</table>

	1.9. Explain the product specification of natural gas. 1.10. Explain the combustion characteristics of natural gas.					
General Objectives 2.0 Comprehend gas processing technologies						
3-4	2.1. Describe the roles of gas plants. 2.2. Describe gas plant processing technologies. 2.3. Explain the piping process. 2.4. Explain the operations of compression stations. 2.5. Describe pigging process. 2.6. Explain gas hydrates and hydrate inhibition. 2.7. Explain the working principles of separators.	Explain the wellhead operations. Explain pigging process. Explain gas hydrates Explain the separator working principle. Explain the thermodynamics of compression. Explain compressor efficiencies. Explain compressor types.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	Explain the wellhead operations. Explain gas hydrates Explain the thermodynamics of compression.
	2.8. Explain the thermodynamics of compression.					

	2.9.Explain the multi-staging process. 2.10. Explain compressor efficiencies. 2.11. List compressor types. 2.12. Describe slug catcher configurations.					
General Objectives 3.0Comprehend the fundamentals of gas treating, gas dehydration, hydrocarbon recovery, nitrogen rejection and trace components recovery						
4-6	3.1. Explain the fundamentals of gas treating. • Absorption and adsorption. • Cryogenic fractionation. • Membrane separation. • Acid gas removal from natural gas. • Merits and limitations of membranes. • Non-regenerable hydrogen sulfide scavengers. 3.2.Explain the fundamentals of gas	Explain the purification levels. Explain the cryogenic fractionation. Explain membranes fundamentals. Describe the membrane processes. Explain the external refrigeration. Explain retrograde	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	Explain the cryogenic fractionation process. Describe the membrane processes. Explain heat exchange and fractionation.

	dehydration • moisture contents of hydrocarbons. • Operating Conditions for TEG Absorbers. • Factors affecting performance of glycol dehydrator • Properties of industrial adsorbents for gas dehydration. • Factors affecting adsorption process. • Explain desiccant processes. • Explain the membrane processes. • Compare dehydration processes 3.3. Explain fundamentals of hydrocarbon recovery. • Describe retrograde	condensation. Explain heat exchange and fractionation. Explain low and high ethane recovery.				

	condensation. • Explain fractionation.. • Discuss low and high ethane recovery processes. 3.4.Explain Nitrogen Rejection for gas upgrading. • Cryogenic Distillation. • Membranes. • Pressure Swing adsorption. 3.5.Explain trace component recovery.					
General Objective 4.0: Appreciate the principles of liquids separation from gas streams						
7-8	4.1 Explain condensate processing. a. Sweetening b. Dehydration 4.2 Describe the following natural gas liquids processing techniques: a. Amine Treating b. Adsorption c. Caustic Treating	Explain natural gas liquids and condensate processing. Describe the categories of natural gas. Explain the fractionation process	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	Explain natural gas liquids and condensate processing.

	d. Adsorption Processes e. Desiccant Dehydration f. Gas Stripping g. Distillation h. Absorption 4.3 Describe fractionation process.					
General objective 5.0: Appreciate the Sulphur Recovery Process.						
9-11	5.1 Explain the properties of sulfur. 5.2 Describe sulfur recovery processes. 5.3 Describe Claus tail gas cleanup 5.4 Explain sulfur storage	Explain the recovery processes. Explain the sulfur storage. Explain the Claus tail gas cleanup	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	Explain sulfur recovery processes

Programme: Higher National Diploma in Petroleum and Gas Processing Engineering (Petrochemical and Gas Processing Option).		
Course Title: Separation Process III	**Code: PGP 412**	**Credit Hour: 2** **Credit Unit:2**
	Pre-requisite: PGP 322	**Theoretical: 2 hours/week**
Year: 2 Semester: 3		**Practical 0 : hours/week**

Goal: The Course is designed to acquaint student with the principles and practices of separation by distillation

General Objectives: On completion of the course, students should be able to:

1.0 Appreciate the principles of separation by distillation.

2.0 Appreciate the principles of separation of multi-component systems by distillation.

3.0 Comprehend azeotropic and extractive distillation/ and absorption.

4.0 Comprehend absorption as both stage wise and counter current contacting processes.

Programme: Higher National diploma in Petroleum and Gas Processing Engineering (Petrochemical and Gas Processing Option).						
Course Title: Separation Process III			**Code: PGP 412**		**CH: 2**	**CU: 2**
Theoretical Content			**Practical Content**			
General Objective 1.0: Appreciate the principles of separation by distillation.						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1-5	1.1 Define the term relative volatility. 1.2 Explain the conditions under which relative volatility can be regarded as constant. 1.3 Define theoretical plate in distillation. 1.4 Calculate vapour liquid equilibrium data for an ideal binary system. 1.5 Calculate by graphical construction, the concentration and temperature profile in a column made up of theoretical	Explain vapour-liquid equilibrium, relative volatility, theoretical stage, total reflux, molar overflow, operating line, molar vaporization, minimum reflux, reflux ratio, Murphree and Overall plate efficiencies, etc. Show explicitly the graphical method of solving distillation problems. Solve several problems. Differentiate between packed columns and plate	Marker & whiteboard , PC & Projector Recommended text.	Determine the number of theoretical stages using McCabe-Thiele and analytical methods.	Guide students to conduct the practical	Explain the conditions under which relative volatility can be regarded as constant

	stage under total reflux. 1.6 Apply Fenske equation to the problem outlined in item 1.5. 1.7 State the assumptions necessary for the use of constant molar overflow and constant molar vaporization. 1.8 Explain the material balance equation of the operating lines for continuous distillation. 1.9 Explain the q value of the feed. 1.10 Explain the concept of minimum reflux rate by identifying pinch conditions. 1.11 Calculate stage requirements in continuous distillation using the McCabe-Thiele	columns. Solve problems using Gilliland correlation				

	method. 1.12 Derive an expression for the minimum reflux ratio for the conditions q=1 and x=constant. 1.13 Apply the Gilliland correlation for estimating theoretical stage requirements. 1.14 Describe the effect of reflux ratio on capital and operating costs 1.15 Define Murphree and overall plate efficiencies. 1.16 Describe the operations of packed distillation column. 1.17 Calculate height equivalent of a transfer plate (H.E.T.P.).					

General Objective 2.0: Appreciate the principles of separation of multi-component systems by distillation.						
5-8	2.1 Explain vapour-liquid equilibrium for multi-component systems. 2.2 State the basis for selecting the relative volatility for multi-component systems. 2.3 Calculate bubble and dew points for ideal multi-component systems. 2.4 Calculate the material balance of product stream compositions for single stage multi-flash vaporization. 2.5 Calculate the distillate and residue composition for a multicomponent differential distillation. 2.6 Identify key components of distillation column. 2.7 Describe the concept	Explain the concept of minimum reflux ratio, theoretical plates, continuous rectification, and stripping section and Feed point location. .	Recommended textbooks, Internet services, etc. White Board, Multimedia projector	Determine feed Point location.	Guide students to determine feed point location	Describe the concept of minimum reflux ratio by identifying pinch points.

	of minimum reflux ratio by identifying pinch points. 2.8 Calculate minimum reflux. 2.9 Calculate the minimum number of theoretical plates. 2.10 Describe the effect of reflux ratio upon the number of theoretical stages using the Gilliland correlation. 2.11 Derive the equations of the operating lines for continuous rectification. 2.12 Carry out plate-to-plate calculations for rectification and stripping sections of the column.					
General Objective 3.0: Comprehend azeotropic and extractive distillation/and absorption.						
9-11	3.1 Define azeotropes and azeotropic distillation. 3.2 Describe principles of separating azeotropes	• Explain clearly the principles of a zeotropic and extractive distillation.	Recommended textbooks, White Board, Multimedia	-	-	Explain clearly the principles of a zeotropic and extractive

	by fractional distillation using entrainers or solvents. 3.3 State the principles and uses of absorption processes as a means of physical separation. 3.3 Compare separation by absorption to fractional distillation	• Show how absorption is a physical separation process. • Compare fractional distillation and absorption. • Identify the various entertainers and solvents in typical a zeotropic and extractive distillation respectively.	projector			distillation.
General Objective 4.0: Comprehend absorption as both stage wise and counter current contacting processes.						
12-15	4.1 Describe the process of absorption. 4.2 Describe the equilibrium data for ideal systems using Raoult's Law. 4.3 Derive equations for the operating lines	• Explain the theory of absorption. • Show how to derive operating line equation	Recommended textbooks, Internet services, etc. White Board,	-	-	Explain the theory of absorption.

	under dilute and concentrated conditions. 4.4 Explain the principles of pinch and minimum solvent requirement. 4.5 Calculate theoretical plate requirements under dilute conditions using the Kreriser-Brown-Sarders equation: a) Analytically. b) Graphically. 4.6 Derive the expression for the packed height of an absorption column under dilute conditions. 4.7 Calculate theoretical plate requirements by graphical construction. 4.8 Calculate gas film coefficient in a wetted column.	with the application of Raoult's law. • Explain Pinch and minimum solvent requirement.	Multimedia projector			

Programme: Higher National Diploma In Petroleum And Gas Processing Engineering – (Petrochemicals And Gas Processing Option)		
Course Title: Process Equipment Fabrication II	**Code: PGP 413**	**Credit Hour: 3** **Credit Unit: 2**
	Pre-requisite:	**Theoretical: 1 hours/week**
Year: 2 Semester: 1		**Practical 2 : hours/week**

Goal: this course is to acquaint students with knowledge and skills in joining and fabrication process equipment

General Objectives: On the completion of the course, the student should be able to:

1.0 Appreciate metal joining processes

2.0: Comprehend electric Arc Welding

3.0: Recognize equipment for Gas welding and cutting

4.0: Outline MIG, MAG and TIG welding processes

5.0: Comprehend welding processes of non - ferrous metals, cast iron and stainless Steel

6.0: Comprehend weld Defects

7.0: Recognize weld symbols and specifications

8.0: Identify machine tools used in fabrication

9.0; Appreciate bending, folding and cutting processes

10.0: Comprehend stiffening of metal sheets and plates

11.0: Appreciate marking out procedures.

Programme: Higher National Diploma In Petroleum And Gas Processing Engineering – (Petrochemical And Gas Processing Option)						
Course Title: Process Equipment Fabrication II			**Code: PGP 413**		**CH: 3 CU: 2**	
Theoretical Content			**Practical Content**			
General Objective 1.0:Appreciate metal joining processes						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1-2	1.1 Explain welding, soldering and brazing 1.2 State the applications of the processes in 1.1. 1.3 State the factors that affect the strengths of joints produced by the processes in 1.1. 1.4 Explain types of bonding materials 1.5 Describe adhesive bonding and application of adhesive bonding materials 1.6 Describe riveting and list types different rivet types	Explain 1.1 to 1.9	Text books • Lecture notes • Whiteboard • Marker. • Drilling machine, drill bits, rivet guns, rivet pins.	1.1 Identify situation where riveting is preferred to welding 1.2 Select for different rivet sizes, the size of matching drill bit. 1.3 Carryout riveting operation.	Demonstrate for the students to learn and guide them to perform activities in 1.1 to 1.3	Explain soldering, brazing and welding

	1.7 Determine the number of rivets required for a given joint					
General Objective 2.0: Comprehend electric Arc Welding						
3-4	2.1 Describe characteristics of AC welding transformer, rectifiers and the DC welding generators 2.2 Explain the functions of a rectifiers of straight and reverse polarity 2.3 Differentiate between AC and DC welding machines. 2.4 Explain the advantages and disadvantages of machine types in 2.3 2.5 Explain the materials used for electrode coating	Explain 2.1 to 2.8	• Welding machine, electrodes Universal welding machine set.	2.1 Identify joints to be welded. 2.2 Carry out joint preparation. 2.3 Select welding nozzles sizes for various material thickness 2.4 Identify and demonstrate the procedures for welding various ferrous and non-ferrous metals.	Demonstrate for the students to learn and guide them to perform activities in 2.1 to 2.4	Explain the procedures for operating a welding machine Explain the various weld joints and how to prepare them. Explain the procedure for multi-run welds. General Objective 3.0: Recognize equipment for Gas welding and cutting Evaluation

	and their functions. 2.6 Explain common problems associated with welding in various positions and their remedy. 2.7 Explain the various weld joints and how to prepare them. 2.8 Describe the procedure for multi-run welds.					
General Objective 3.0: Appreciate equipment for gas welding and cutting						
5	3.1 Describe the operations of: (a) welding regulator (b) welding blowpipe (c) cutting blowpipe. 3.2 Describe the procedure for lighting the welding torch and closing. 3.3 Explain the applications of	Explain 3.1 to 3.5	• Oxy-acetylene sets - 5 • Flash gas lighter • Steel rule • Tri-square. General Objective 4.0: Outline MIG, MAG and TIG	-	-	Explain MIG and MAG welding processes

	different types of flames. 3.4 Explain different cutting nozzles 3.5 Explain welding nozzles (sizes) for various material thicknesses.		welding processes Resources Universal welding machine set. Welding electrodes for specific jobs.			
General Objective 4.0: Outline MIG, MAG and TIG welding processes						
6	4.1 Explain the types of gases used for shielded arc welding, their areas of application and effects on welds. 4.2 Describe the principles of operation of a submerged arc welding 4.3 State the equipment and filler materials used in 4.2	Explain 4.1 to 4.3	Universal welding machine set. Welding electrodes for specific jobs.	-	-	Explain MIG and MAG welding processes

General Objective 5.0: Comprehend welding processes of non - ferrous metals, cast iron and stainless Steel						
7	5.1 Explain the problems involved in welding copper and its alloys 5.2 Describe the problems involved in welding aluminum and its alloys 5.3 State the procedure for fusion welding of cast iron and stainless steel. 5.4 Describe other methods of welding cast iron other than fusion welding.	Explain 5.1 to 5.4	Text books • Lecture notes • Whiteboard • Marker.	-	-	Explain welding processes of non - ferrous metals, cast iron and stainless Steel
General Objective 6.0: Comprehend weld Defects						
8-9	6.1 Explain the various types of weld defects and their causes. 6.2 Describe the following types of weld defects: (i) distortion (ii) lack of penetration (iii) slag inclusion (iv)	Explain 6.1 to 6.7	Text books • Lecture notes • Whiteboard • Marker.	6.1. Identify weld defects and ways of remedying them.	Demonstrate for the students to learn and guide them to identify weld defects and ways of remedying them	Explain the various types of weld defects and their causes.

	undercutting cracks (v) lack of fusion blow holes 6.3 Explain the nature and causes of distortion 6.4 Explain methods of eliminating distortion and cracking by means of the skip and step back methods, pre and post heating peening welding from free to fixed zone, etc. 6.5 Describe correct weld profiles and dimensions 6.6 Explain the reasons for dressing welds. 6.7 Explain the concept of stress relief in weld merits.					
General Objective 7.0: Recognize welding symbols and specifications						
10	7.1 Explain various weld symbols and their interpretation. 7.2 Interpret welds in drawings 7.3Describe suitable	Explain 7.1 to 7.3	Textbooks • Lecture notes • Whiteboard • Marker.	7.1 Identify various weld symbols and interpret them. 7.2 Identify welds	Demonstrate for the students to learn and guide them to perform 7.1 to 7.2	Explain weld symbols and specifications

	weld joints.			in drawings		
General Objective 8.0: Identify machine tools used in fabrication						
11	8.1 Explain shearing. 8.2 Explain the working principles and uses of the following cutting machines (a) Guillotine (b) Nibbling machine (c) Cropping machine (d) Shearing machine (e) Sawing machine. 8.3 State the advantages and limitations of each of the machines in 8.2	Explain 8.1 to 8.3	• Profile cutting machine • Bending other • Spinning machine • Foot operated. guillotine	-	-	Explain machine tools used in fabrication
General Objective 9.0; Appreciate bending, folding and cutting processes						
12	9.1 Explain bending action 9.2 Explain the working principle	Explain 9.1 to 9.4	Textbooks, Whiteboard etc. • Profile cutting machine	-	-	Explain bending, folding and cutting processes

	of form machines (a) fly - press (b) hydraulic press (c) press brake (d) folding machines (e) rolling machine (f) bending rolls 9.3 Describe the various operations carries out on the above machine (a) bending (b) edge curving (c) straightening (d) bottoming folding (f) rolling of sheet and plate materials 9.4 State advantages and limitations of the machines in 9.2.		• Bending other • Spinning machine • Foot operated. Guillotine			
General Objective 10.0: Comprehend stiffening of metal sheets and plates						
13	10.1 Explain stiffening in fabrication.	Explain 10.1 to 10.3	Profile cutting machine	-	-	Explain stiffening in

	10.2 Explain reasons for stiffening 10.3 Describe the following methods of stiffen sheet metal (a) wired edge (b) folded edge (c) swaging 10.4 Describe the following methods of stiffening plates and structural members (a) web stiffening (b) troughing (c) channeling (d) Ribbing.		• Bending machine • Spinning machine • Foot operated guillotine roller.			fabrication. State reasons for stiffening
General Objective 11.0: Appreciate marking out procedures						
14-15	11.1 Explain the importance of marking out profiles in fabrication. 11.2 Describe the concept of material economy in marking out profiles from sheet metal or plates. 11.3 Explain the	Explain 11.1 to 11.3	• Basic marking out tools. Profile cutting machine • Bending machine • Spinning machine • Foot operated guillotine roller.	11.1 Demonstrate the procedure for mark out profiles of (i) Cone (ii) Frustum (iii) Rectangular vessel (iv) Rectangular vessel with folded edge.	Demonstrate 11.1.	Explain the importance of marking out profiles in fabrication

	procedure for correctly setting marking - out profiles of (i) cone (ii) frustum of a curve (iii) Rectangular vessel (iv) Rectangular vessel with folded edge.					

PROGRAMME: HIGHER NATIONAL DIPLOMA IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (GAS PROCESSING OPTION)		
COURSE TITLE: Gas Processing Laboratory Techniques II	**Code:** PGP 414	**Credit Hour: 3** **Credit Unit: 2**
	Pre-requisite:	**Theoretical: 0 Hours/week**
Year: 2 Semester: 1		**Practical: 3 Hours/week**

Goal: This course is designed to enable students acquire practical knowledge of gas thermodynamics, gas absorption, heat exchange, gas analysis, and working principles of pumps, compressors and valves.

General Objectives: On completion of the course, the student should be able to:

1.0 Perform experiments on gas thermodynamics
2.0 Perform experiments on gas absorption.
3.0 Perform experiments on gas heat exchange.
4.0 Perform experiments on burning quality of natural gas
5.0 Perform experiments on gas characterization
6.0 Evaluate performance of pumps and compressors
7.0 Evaluate performance of flow meters and valves

PROGRAMME: HIGHER NATIONAL DIPLOMA IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (GAS PROCESSING OPTION)						
COURSE TITLE: GAS PROCESSING LABORATORY TECHNIQUES II				**Code: PGP 414**	**CH: 3**	**CU: 2**
Theoretical Content				**Practical Content**		
General **Objectives 1.0** Perform experiments on gas thermodynamics.						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1-2	-	-	Practical manual, for heat capacity ratio, ratio of volume, and practical manual on saturation pressure. Temperature and pressure measuring devices.	1.1 Determine heat capacity ratio 1.2 Determine gas streams volume ratio using isothermal process 1.3 Observe characteristic behavior of a two-phase fluid 1.4 Determine saturation pressure of a fluid 1.5 Determine relationship between pressure and temperature of vaporization of a fluid. 1.6 Determine quality of the steam exiting a pressurized vessel	Guide students to follow the procedure given in the manual and conduct the experiments.	Identify the equipment used for the experiment Explain the heat capacity ratio and ratio of volume for an isothermal process. Explain the relationship between temperature and pressure as related to gas thermodynamics.
General Objective 2.0: Perform experiments on gas absorption.						
3-5	-	-	Practical manual, gas absorption equipment.	2.1 Measure the efficiency of lean oil absorption process 2.2 Determine air pressure differential across dry column as	Guide students to follow the procedure given in the manual and conduct the experiments.	Identify gas absorption equipment. Explain the working principles of gas absorption

				a function of the air flow rate. 2.3 Determine air pressure differential across a wet column as a function of air flow rate 2.4 Determine the effect of pressure drop, loading and flooding on packed absorption column performance. 2.5 Determine extraction efficiency for different packings		with various packings Explain the effect and causes of flooding in the packed absorption column**.**
General Objective 3.0: Perform experiments on gas heat exchange						
6-8	-	-	Practical manual, shell and tube heat exchanger, plate heat exchanger, Tubular heat exchanger	3.1 Determine heat exchange efficiency in co-current and countercurrent flow 3.2 Determine overall heat transfer coefficient using various heat exchangers 3.3 Determine energy balance and overall efficiency of various heat exchangers	Demonstrate how heat exchanger equipment operates. Guide students to follow the procedure given in the manual and conduct the experiments.	Explain the working of shell and tube heat exchanger, plate heat exchanger and tubular heat exchanger.
General Objective 4.0: Perform experiments on burning quality of natural gas						
9	-	-	Practical manual on gas analysis and characterization	4.1 Prepare gas samples 4.2 Determine Flame propagation	Demonstrate how various gas analyzer/ equipment operate. Guide students to	Explain the working principle of flame propagation

				characteristics of burning gaseous fuel 4.3 Interpret the results	follow the procedure given in the manual and conduct the experiments.	characteristics
General Objective 5.0: Perform experiments on gas characterization						
10-11	-	-	Practical Manual for Mass spectrometry (MS) Fourier transform infrared technology (FTIR), Gas chromatography (GC)	5.1 Prepare gas samples 5.2 Determine natural gas composition 5.3 Interpret the results	Demonstrate how Mass Spectrometry, Fourier Transform Infrared Technology and Gas Chromatography equipment operate. Guide students to follow the procedure given in the manual and conduct the experiments.	Explain the working of Mass spectrometry (MS) Fourier transform infrared technology, (FTIR) and Gas chromatography (GC)
General Objectives 6.0: Evaluate performance of pumps and compressors						
12-13	-	-	Practical manual pump and compressors	6.1 Perform the necessary checks for start up 6.2 Start up the unit 6.3 Determine operating characteristics of centrifugal pumps, gear pumps, axial pumps and positive displacement pumps 6.4 Interpret the results	Guide students to determine the operating characteristics of pumps. Guide students to follow the procedure given in the manual and conduct the experiments.	Identify various pumps. Explain the working principles of pumps
General Objectives 7.0: Perform experiments on valve and compressors						
14-15	-	-	Practical manual valve and compressor	7.1 Determine pressure drop on gas pipeline using principle of J-T	Guide students to: Determine the operating characteristics of valve	Identify various valves and compressors.

				valves 7.2 Determine efficiency of compressors	and compressor Determine the effect of pressure drop on gas pipeline.	Explain the working principles of valves and compressors.

PROGRAMME: HIGHER NATIONAL DIPLOMA IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY		
COURSE TITLE: Advanced Technical Report Writing	**Code: PGP 415**	**Credit Hour: 1** **Credit Unit:1**
	Pre-requisite:	**Theoretical: 1 hours/week**
Year: 2 Semester: 1		**Practical: 0 hour/week**

GAOL: This course is designed to provide students with a broad knowledge on technical reports and research methods.

GENERAL OBJCTIVES:

At the end of this course, the student should be able to:

1. Appreciate the different types of technical reports
2. Comprehend the concept of scientific research
3. Appreciate the basics of data collection and analysis
4. Appreciate the guidelines required for project execution and report writing
5. Comprehend citation /referencing
6. Comprehend oral presentation of technical report

PROGRAMMES: HIGHER NATIONAL DIPLOMA IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY						
Course Title: ADVANCED TECHNICAL REPORT WRITING			**Code:** PGP 415		**CH: 1** **CU:1**	
Theoretical Content			**Practical Content**			
General Objective Appreciate the different types of technical reports						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1 - 2	1.1. Define technical report 1.2. State types of technical report. 1.3. Explain scientific integrity in research and publication: plagiarism and copyright.	List types of technical report: formal and informal (final year students' projects, research findings, design and development etc.) Guide students in the usage of appropriate plagiarism software such as Turnitin.	Textbooks, software, journals, internet materials.	–	–	State types of technical report.

General Objectives 2.0 Comprehend the use of numerical methods in solving sets of linear and nonlinear equations.						
3 - 5	2.1 Explain concept of research 2.2 Describe types of research: pure and applied 2.3 Classify research based on objectives, application, inquiry etc. 2.4 Explain characteristics of a good research: objectivity, precision, design, and verifiability. 2.5 Describe research hypothesis 2.6 Explain scientific research process 2.7 Mention steps in research process 2.8 Explain literature review: Sources of Information 2.9 Describe formulation of research objectives	Explain activities in 2.1 to 2.9	Textbooks, journals, internet materials.	-	-	Classify research based on objectives, application and inquiry
General Objective 3.0 Appreciate the basis of Data collection and analysis						
6 - 8	3.1 Describe sampling and sample size 3.2 List types of data: Primary and secondary data 3.3 Describe methods of data collection: experimental, observation, research questions etc.	Explain activities in 3.1 to 3.5	Textbooks, journals, internet materials	-	-	Explain methods of data collection

	3.4 Analyze data 3.5 Prepare the research design					
General Objective 4.0 Appreciate the guidelines required for project execution and report writing						
9 - 11	4.1 State final year project's execution guidelines 4.2 Explain the concept of the following: introduction, literature review, procedure, result, analysis, interpretation, discussion, conclusion, recommendation, abstract, references, appendices, equations, figures, tables, numerical data, and units 4.3 Explain the importance of correct grammar, spellings, acronyms, and abbreviations in technical report writing 4.4 Describe the format for preliminary pages in project report writing: cover page, title page, certification page, dedication, acknowledgement, table of content.	Guide the students in using appropriate grammar tools such as Grammarly. Explain activities in 4.1 to 4.4	Textbooks, software, journals, internet materials	-	-	State the contents of introduction in technical report writing.
GENERAL OBJECTIVE 5.0 Comprehend citation and referencing						
12 - 13	5.1 Mention citation methods 5.2 Describe citation styles (e.g APA, Harvard, ISO 690)	Explain the use of citation and referencing	Textbooks, software, journals,	-	-	Explain different citation methods

	5.3 Describe in-text referencing and text referencing 5.4 Explain styles of referencing	software such as References in Microsoft word, Mendeley etc.	internet materials			
General Objective 6.0 Comprehend oral presentation of technical report.						
14 - 15	6.3 Explain the following concepts in oral presentation of technical report: Analysis of audience, Mode of presentation, Introductory part of presentation, Body of presentation, Conclusion, and Visual aids. 6.4 Explain tips for good oral presentation	Guide students on the usage of PowerPoint.	Textbooks, software, journals, internet materials	-	-	Explain tips for good oral presentation

PROGRAMME: HIGHER NATIONAL DIPLOMA IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (PETROCHEMICAL AND POLYMER OPTION)		
COURSE TITLE: FERTILIZER TECHNOLOGY	**Code: PPT 411**	**Credit Hour: 2** **Credit Unit:2**
	Pre-requisite:	**Theoretical: 2 hours/week**
Year: 2 Semester: 1		**Practical: 0 hour/week**

Goal: This course is designed to provide students with knowledge of the principles and applications of fertilizer production

General Objectives:

On the completion of the course, the student should be able to:

11.0 Comprehend the uses of fertilizers in crop production

12.0 Appreciate ammonia in nitrogenous fertilizers production

13.0 Comprehend the chemistry of urea production in nitrogenous fertilizer

14.0 Comprehend the production of Phosphatic Fertilizers

15.0 Comprehend the production of Potassic Fertilizers

16.0 Comprehend the blending of Fertilizers

17.0 Comprehend the concept of Bio-fertilizers production

<table>
<tr><td colspan="7">PROGRAMME: HIGHER NATIONAL DIPLOMA IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (PETROCHEMICAL & POLYMER OPTION)</td></tr>
<tr><td colspan="4">COURSE TITLE: FERTILIZER TECHNOLOGY</td><td>Code: PPT 411</td><td colspan="2">CH:2 CU:2
Theoretical: 2 Hours/week
Practical: 0 Hours/week</td></tr>
<tr><td colspan="4">Theoretical Content</td><td colspan="3">Practical Content</td></tr>
<tr><td colspan="7">General Objective: 1.0 Comprehend the uses of Fertilizers in crop production</td></tr>
<tr><td>Week</td><td>Specific Learning Outcomes</td><td>Teacher's Activities</td><td>Resources</td><td>Specific Learning Outcomes</td><td>Teacher's Activities</td><td>Evaluation</td></tr>
<tr><td>1-3</td><td>1.1 Explain the need for synthetic fertilizer
1.2 List types of fertilizers
1.3 Describe the role of essential elements for plant growth.
1.4 State the relevant fertilizers for the different types of crops</td><td>Provide a general overview of synthetic fertilizer

Describe the relevant fertilizer for different types of crop.</td><td>Textbooks, Charts, journals, internet materials.</td><td>-</td><td>-</td><td>Explain the role of fertilizer in crop production

Mention types of fertilizer</td></tr>
<tr><td colspan="7">General Objectives: 2.0 Appreciate ammonia in nitrogenous fertilizers production</td></tr>
<tr><td>4-5</td><td>2.1 Describe the production of synthesis gas
2.2 Describe the chemistry and technology of Ammonia production
2.3 Describe properties of Ammonia</td><td>Explain the manufacturing of synthesis gas and ammonia</td><td>Textbooks, journals, internet materials.</td><td>-</td><td>-</td><td>Describe the chemistry of ammonia production</td></tr>
</table>

General Objectives: 3.0 Comprehend the chemistry of urea production in nitrogenous fertilizer						
6-7	3.1 Describe the chemistry and process technology for urea production 3.2 Describe the chemistry and process technology for nitric acid and nitrates production 3.3 Describe various properties of Urea, nitric acid, and nitrates	Use PFD to describe urea and nitric acid production	Textbooks, journals, internet materials.	-	-	Describe the chemistry of urea production
General Objectives: 4.0 Comprehend the production of Phosphatic Fertilizers						
8-9	4.1 Explain physical and chemical properties of Phosphorus and Phosphoric acid 4.2 Describe the extraction process of Phosphorus 4.3 Describe the production process of phosphoric acid 4.4 Explain the production of sulphuric acid	Use PFD to describe the production of phosphoric acid	Textbooks, journals, internet materials.	-	-	Describe the manufacturing of phosphorus Describe the chemistry of phosphoric acid production
General Objectives: 5.0 Comprehend the production of Potassic Fertilizers						

10-11	5.1 Describe physical and chemical properties of Pottasic fertilizers 5.2 Explain production process of potassium Chloride from sylvinite 5.3 Describe the production of potassium nitrate, and potassium sulphate	Describe using PFD production of potassium nitrate and potassium sulphate	Textbooks, journals, internet materials.	-	-	Explain the physical and chemical properties of potasic fertilizers
General Objectives: 6.0 Comprehend the blending of Fertilizers						
12-13	6.1 Describe fertilizer blending plant 6.2 List equipment for fertilizer blending plant	Draw PFD for fertilizer blending plant.	Textbooks, journals, internet materials.	-	-	Describe complex fertilizer. Explain a fertilizer blending plant
General Objectives: 7.0 Comprehend the concept of Bio-Fertilizer Production						
14-15	7.1 Describe the Nitrogen fixing and Phosphate solubilizing bio-fertilizers 7.2 Describe the properties of bio-fertilizers 7.3 Describe the production of bio-fertilizers.	Describe biofertilizers	Textbooks, journals, internet materials.	-	-	Describe bio fertilizer. Explain pollution control in a fertilizer plant

<table>
<tr><td colspan="3">PROGRAMME: HIGHER NATIONAL DIPLOMA (HND) IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (GAS PROCESSING OPTION)</td></tr>
<tr><td>COURSE TITLE: Natural Gas Thermodynamics</td><td>Code: GPT 411</td><td>Credit Hour: 2
Credit Unit:2</td></tr>
<tr><td></td><td>Pre-requisite:</td><td>Theoretical: 2 hours/week</td></tr>
<tr><td>Year: 2 Semester: 2</td><td></td><td>Practical : 0 hours/week</td></tr>
</table>

Goal: The course is designed to equip students with advance knowledge of natural gas thermodynamic concepts and its application in the Oil and Gas Industry

General Objectives: On completion of this course students should be able to:

1.0 Comprehend and apply the first law of thermodynamics to natural gas

2.0 Appreciate the second law of thermodynamics and its application in gas processing

3.0 Comprehend the behaviour of ideal and real gases

4.0 Appreciate thermodynamics properties of natural gas

5.0 Comprehend the application of ideal and non-ideal solutions

6.0 Appreciate the Gas Power System and Vapor Combine Power System

7.0 Comprehend Refrigeration and liquefaction

8.0 Application of thermodynamics in Liquefied Natural Gas (LNG) production

PROGRAMME:HIGHER NATIONAL DIPLOMA (HND) PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (GAS PROCESSING OPTION)						
COURSE TITLE: NATURAL GAS THERMODYNAMICS				Code: GPT 411	CH: 2 CU:2 Theoretical: 2 Hours/week Practical: 0 Hours/week	
Theoretical Content				Practical Content		
GENERAL OBJECTIVE 1.0: Comprehend and apply the first law of thermodynamics to natural gas						
Week	Specific Learning Outcomes	Teacher's Activities	Resources	Specific Learning Outcomes	Teacher's Activities	Evaluation
1-2	1.1 State the first law of thermodynamics 1.2 Explain the concept of system boundary and surroundings 1.3 Explain closed and open systems 1.4 Relate internal energy, heat, and work in a closed system 1.5 Perform energy balance in closed and open systems 1.6 Explain heat capacity and enthalpy 1.7 Describe mechanically reversible processes 1.8 Apply the first law of thermodynamics to natural gas flow systems	Demonstrate the first law of thermodynamics using calorimetry	Whiteboard, computer, projector, recommended text books, lecture notes, and related journals.	-	-	State the first law of thermodynamics Describe mechanically reversible processes
General Objective 2.0: Appreciate the second law of thermodynamics and its application in gas processing						
3-4	2.1 Explain the concepts of thermodynamic reversibility. 2.2 State the second law of thermodynamics 2.3 Define change in entropy	Explain activities in 2.1-2.7	Whiteboard, computer, projector, recommended text books, lecture	-	-	Explain Carnot and Rankine cycles

	2.4 Explain entropy chances for chemical reactions 2.5 Explain entropy changes for phase transitions 2.6 Explain Carnot and Rankine cycles 2.7 Apply the concepts in Carnot and Rankine cycles to solve problems in gas turbine power plant		notes, and related journals.			
General Objectives 3.0: Comprehend the behaviour of ideal and real gases						
5-6	3.1 Explain the deviation of real gas from the ideal gas 3.2 Explain compressibility factor 3.3 Explain the Van der Waal's modifications of the ideal gas equation. 3.4 Explain the use of virial equations to represent the behaviour of real gases 3.5 Explain the properties of mixtures of ideal and non-ideal gases 3.6 Explain phase equilibria 3.7 Use Clapeyron and Clausius-Clapeyron equations to describe liquid-vapor equilibria 3.8 Calculate composition of vapor in equilibrium with liquid	Explain activities in 3.1-3.8	Whiteboard, computer, projector, recommended text books, lecture notes, and related journals.	-	-	Explain the properties of mixtures of ideal and non-ideal gases

General Objectives 4.0: Appreciate thermodynamics properties of natural gas						
7	4.1 Compare composition of Natural Gas from different fields 4.2 Explain Ideal and Real Gas mixtures behavior 4.3 Describe P-V-T Relations for Gas Mixtures 4.4 Interpret tables of thermodynamic properties 4.5 Interpret Generalized Charts for Enthalpy and Entropy 4.6 Describe the thermodynamic properties from pressure-volume-Temperature and specific heat Data 4.7 Explain Multicomponent System	Explain activities in 4.1-4.7	Whiteboard, computer, projector, recommended text books, lecture notes, and related journals.	-	-	Explain Ideal and Real Gas mixtures behavior
General Objective 5.0: Comprehend the application of ideal and non-ideal solutions						
8-9	5.1 Explain the use of chemical potential 5.2 Explain the relationship between activities and reaction equilibrium 5.3 State and apply Raoult's law 5.4 State and apply Henry's Law 5.5 Explain the application of Raoult's and Henry's Laws to ideal solution 5.6 State the third law of thermodynamics	Explain activities in 5.1-5.6	Whiteboard, computer, projector, recommended text books, lecture notes, and related journals.	-	-	Explain the application of Raoult's and Henry's Laws to ideal solution
General Objective 6.0: Appreciate the Gas Power System and Vapor Combine Power System						
10-11	6.1 Explain Power Cycles 6.2 Describe internal combustion engines 6.3 Explain Gas cycles 6.4 Describe Carnot Cycle and its	Explain activities in 6.1-6.8	Whiteboard, computer, projector, recommended text books, lecture notes, and related	-	-	Describe internal combustion engines

	significance in gas power plants 6.5 Describe the Ideal Cycle for Gas-Turbine Engines. 6.6 Describe Gas Turbine Power Plants 6.7 Describe the Rankine Cycle 6.8 Perform energy analysis of an Ideal Rankine Cycle		journals.			
General Objective 7.0: Comprehend Refrigeration and liquefaction						
12-13	7.1 Explain Gas and vapor Refrigeration Systems 7.2 Explain refrigeration cycle 7.3 Analyze Vapor-Compression Refrigeration Systems 7.4 Explain Refrigerant Properties 7.5 Explain Cascade Refrigeration Systems and 7.6 Multistage Compression Systems 7.7 Explain Adsorption and Absorption Refrigeration Systems 7.8 Explain Joule-Thompson effect in the liquefaction of gases 7.9 Explain environmental impact of Refrigerants	Describe the Ideal Vapor-Compression Refrigeration Cycle Discuss the actual Vapor-Compression Refrigeration Cycle	Whiteboard, computer, projector, recommended text books, lecture notes, and related journals.	-	-	Explain Gas and vapor Refrigeration Systems Explain Refrigerant Properties
General Objective 8.0: Application of thermodynamics in Liquefied Natural Gas (LNG) production						
14-15	8.1 Describe sale gas 8.2 Explain dew point temperature 8.3 Describe cryogenics and natural gas liquefaction 8.4 Explain natural gas phase diagram	Describe LNG power plant	Whiteboard, computer, projector, recommended text books, lecture notes, and related	-	-	Describe LNG production process

	8.5 Describe T-S diagram for a liquefaction process 8.6 Describe LNG production process 8.7 Describe LNG plant 8.8 Explain Safety measures in LNG production 8.9 State the quality requirements for LNG		journals.			

PROGRAMME: HIGHER NATIONAL DIPLOMA HND IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (GAS PROCESSING OPTION)		
COURSE TITLE: LIQUIFIED NATURAL GAS (LNG) TECHNOLOGY	**Code: GPT 412**	**CH: 2 CU: 2**
	Pre-requisite:	**Theoretical: 2 Hours/week**
Years: 2 Semester: 2		**Practical: 0 Hours/week**

Goal: This course is designed to acquaint the students with the fundamental knowledge of Liquefied Natural Gas Production, Storage, Transportation and Distribution

General Objectives:

On completion of this course, the students should be able to:

1. Comprehend the overview of LNG Industry
2. Comprehend LNG Properties
3. Comprehend LNG Production
4. Appreciate Technology of LNG Specific Equipment
5. Appreciate LNG Hazard Prevention & Mitigation Measures
6. Recognize LNG Storage, Loading/Offloading & Transport facilities
7. Comprehend LNG Specifications and Quality Requirements
8. Appreciate Health, Safety, and Environmental issues associated with LNG

PROGRAMME: HIGHER NATIONAL DIPLOMA HND IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (GAS PROCESSING OPTION)						
COURSE TITLE:LIQUEFIED NATURAL GAS (LNG) TECHNOLOGY			**Course Code:** GPT412		**CH:2 CU:2**	
Theoretical Content			Practical Content			
General Objective 1.0: Comprehend the overview of LNG Industry						
week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
	1.1 Describe World Natural Gas and LNG Scenario 1.2 Explain Nigerian Natural Gas Policy 1.3 Describe Nigerian LNG Projects 1.4 Explain LNG contracts: specificities of LNG contracts, pricing, shipping contracts 1.5 Describe LNG markets trends	Explain activities in 1.1 – 1.5	White board, recommended textbooks, lecture notes, related Journals, etc.	-	-	Explain LNG contracts: specificities of LNG contracts, pricing, shipping contracts
GENERAL OBJECTIVE 2.0: Comprehend LNG Properties						
	2.1 Explain LNG Physical properties: liquid-vapor equilibrium, density, ratio of vapor (methane/LNG), heat of vaporization, heat of combustion 2.2 Explain LNG Properties associated with Safety: flash point, fire point, auto-ignition point, minimum spark energy, flammability limits, deflagration. 2.3 Explain LNG Properties associated with Health:	Explain LNG Properties associated with HSE	White board, recommended textbooks, lecture notes, related Journals, etc.	-	-	State LNG vaporization properties

	Asphyxiation risks, cryogenic liquids jets, piping behavior. 2.4 Explain LNG vaporization properties: Rapid Phase Transition (RPT), radiation levels, stratification/roll-over, sloshing, LNG clouds ignition.					
GENERAL OBJECTIVE 3.0: Comprehend LNG Production						
	3.1 Explain LNG Feed pretreatment: sweetening, dehydration, NGL extraction, Hg removal, Nitrogen rejection and Helium recovery. 3.2 Describe Precooling and refrigeration 3.3 Describe Liquefaction processes: Single mixed refrigerants, Dual mixed refrigerant, mixed fluid cascade. 3.4 Explain Subcooling 3.5 Describe LNG Plant layout	Describe feed preparation for LNG plant	White board, recommended textbooks, lecture notes, related Journals, etc.	-	-	Explain Natural Gas Liquefaction processes
GENERAL OBJECTIVE 4.0: Appreciate Technology of LNG Specific Equipment						
	4.1 Describe LNG cryogenic heat exchangers: spiral wound heat exchangers, aluminum brazed heat exchangers. 4.2 Describe cryogenic compressors and their drivers (gas turbines). 4.3 Describe LNG Vaporizers: Open Rack Vaporizers (ORV), Submerged Combustion Vaporizers (SCV), etc. 4.4 Describe Submerged LNG pumps: in-tank retractable pumps, cargo pumps, HP canned send out pumps, etc. 4.5 Describe Liquid cryogenic turbo-expanders, and	Explain LNG pre-cooling equipment	White board, recommended textbooks, lecture notes, related Journals, etc.	-	-	Explain LNG cryogenic heat exchangers Explain Cryogenic personnel protective

	cryogenic valves. 4.6 Describe Cryogenic personnel protective equipment 4.7 Recognize the latest LNG trends in equipment development					equipment
GENERAL OBJECTIVE 5.0: Appreciate LNG Hazard Prevention & Mitigation Measures						
	5.1 Explain LNG spillage control at design stage and during operation. 5.2 Explain LNG clouds control during operation. 5.3 Explain LNG fires control at design stage and during operation.	Explain activities in 5.1 – 5.3	White board, recommended textbooks, lecture notes, related Journals, etc.	**-**	**-**	Explain LNG spillage control at design stage and during operation.
General Objective 6.0: Recognize LNG Storage, Loading/Offloading & Transport facilities						
1-2	6.1 Describe LNG tanks: single or double or full containment (self-standing, membrane). 6.2 Describe LNG carriers: common features, technology, cargo operations, safety systems. 6.3 Describe LNG carrier technologies (Floating production, storage and offloading systems FPSO, Floating storage and offloading systems FSO, Floating storage and regasification units FSRU etc) 6.4 Describe Receiving Terminals 6.5 Carryout Cargo measurement and calculations 6.6 Describe LNG Transportation and Distribution	Describe LNG carriers and carrier technologies Describe Receiving Terminals Carryout Cargo measurement and calculations in LNG terminals	White board, computer, Related software, projector, textbooks, Lecture note and related journals	-	-	Explain LNG carriers and carrier technologies

General Objective 7.0: Comprehend Liquefied Natural Gas Specifications and Quality Requirements						
3-4	7.1 Explain Acid gases and moisture content 7.2 Explain Hydrocarbon dew points 7.3 Explain Heating value 7.4 Explain Energy Density 7.5 Explain Wobbe index, sooth index, yellow tip index etc	Explain activities in7.1-7.5	White board, recommended textbooks, lecture note, related journals Internet materials, computer related software.	-	-	Explain Hydrocarbon dew points
General Objective 8.0: Appreciate Health, Safety, and Environmental issues associated with LNG						
5-6	8.1 Explain LNGs Handling & Safety Procedures 8.2 Describe safety design of LNG facilities 8.3 Explain the need of security in storage and transportation of LNG 8.4 Explain how to carry out risk-based analysis of an LNG plant.	Describe how to carry out risk-based analysis of an LNG plant. .	White board, Recommended textbooks, Lecture note computer related software, internet related material and related journals	-	-	Explain the need of security in storage and transportation of LNG

<table>
<tr><td colspan="3">Programme: (Higher National Diploma) in Petroleum and Gas Processing Engineering (Petrochemical and Gas Processing Option).</td></tr>
<tr><td>Course: Advanced Petrochemical Process Technology II</td><td>Course Code: PPT 412</td><td>Contact Hours : 2
Credit Unit: 2
Theoretical: 2 hours/week</td></tr>
<tr><td>Year: 2 Semester: 2</td><td>Pre-requisite-</td><td>Practical: 0</td></tr>
<tr><td colspan="3">Goal: This course is designed to provide the students with basic knowledge of petrochemical feedstock and their derivatives</td></tr>
<tr><td colspan="3">General Objectives: On completion of this course, the student should be able to:

1.0 Appreciate the process technology for the production of aromatic
2.0 Appreciate the process technology for aromatics-BTX derivatives
3.0 Appreciate process technology for production of Polymers
4.0 Appreciate process technology for production of Elastomers and Polyurethanes
5.0 Appreciate process technology for production synthetic fiber</td></tr>
</table>

Programme: (Higher National Diploma) in Petroleum and Gas Processing Engineering (Petrochemical and Gas Processing Option).						
Course Title: Advanced Petrochemical Process Technology II				**Code: PGP 422 CH:2 CU:2**		
	Theoretical Content			**Practical Content**		
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
General Objective 1.0 Appreciate process technology for the production of aromatic						
1-3	1.1 State the relevance of aromatics hydrocarbons to the petrochemical industry 1.2 Identify the major sources of aromatic hydrocarbon 1.3 List commercial technologies for BTX production 1.4 Identify petroleum feedstock for	• Explain the importance of aromatics petrochemical industry • With the aid of process flow diagram describe catalytic reforming of naphtha to aromatics • Identify commercial technologies for BTX production • Distinguish	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	With the aid of process flow diagram describe catalytic reforming of naphtha to aromatics

	production of aromatics 1.5 Enumerate the main processing scheme in catalytic reforming of naphtha and pyrolysis gasoline conversion for production of aromatics 1.6 State different configuration of reformers used in naphtha reforming 1.7 State the reactions involve in catalytic reforming 1.8 Describe typical catalyst system in reforming process 1.9 Present a typical operating condition in catalytic	between the constituents of naphtha and pyrolysis gasoline • Identify different types of reformer used in aromatic production • State the catalyst and operating conditions in catalytic reforming process • Explain the effect of process variable in catalytic reforming process • Draw a schematic diagram for aromatic extraction and separation • State the application of P-				

	reforming unit 1.10 Explain process variable in catalytic reforming 1.11 Explain aromatic extraction and separation process 1.12 State the importance of P-xylene 1.13 Present typical feed constituent for P-xylene production 1.14 Identify various units in P-xylene plant 1.15 Present a typical process flow diagram of catalytic reforming of naphtha to P-xylene 1.16 Identify commercial technologies	xylene • Draw a typical process flow diagram of catalytic reforming of naphtha to P-xylene • With the a aid of a process flow diagram describe BP-UOP cycler process • With the aid of a block diagram explain toluene disproportionation process • With the a aid of a process flow diagram describe hydride alkylation of toluene • With the a aid of a process flow diagram • Describe Isomerization of				

	for p-xylene separation process 1.17 Describe BP-UOP cycler process technology for the conversion of LPG to BTX 1.18 Present a process flow diagram of BP-UOP cycler process 1.19 State the purpose of toluene conversion to other aromatics 1.20 Explain the evolution of Toluene disproportionation process 1.21 Present a block diagram of toluene disproportionation process 1.22 Describe hydride alkylation of toluene to	C8 residual • Mention major commercial licensors of xylene isomerization process				

	benzene 1.23 Explain the importance of Isomerization of C_8 residual to o- and p-xylene 1.24 Identify major commercial licensors of xylene isomerization process 1.25 Describe technologies for 1.24 above.					
General Objective 2.0: Appreciate process technology for aromatics-BTX derivatives						
4-6	2.1 Explain the relevance of BTX derivatives to the petrochemical industry 2.2 List various important chemicals obtainable from BTX 2.3 Identify the application of	• Explain the application of BTX • Present with the aid of chart derivative from BTX • Explain the application of ethyl benzene and styrene • Explain with the aid of process flow diagram the technology for the	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	Explain with the aid of process flow diagram thetechnology for the production of ethyl benzene and styrene from benzene

	ethyl benzene and styrene 2.4 Identify major commercial technologies for ethyl benzene and styrene production 2.5 Describe the process technology for the production of ethyl benzene and styrene from benzene 2.6 Identify the application of phthalic anhydride 2.7 Identify different route for phthalic anhydride production 2.8 Describe the process technology for the production of phthalic	production of ethyl benzene and styrene from benzene • Explain the application of phthalic anhydride • Explain with the aid of process flow diagram the technology for the production of phthalic anhydride • Explain the application of LAB • Explain with the aid of process flow diagram the technology for the production of LAB from kerosene and HF alkylation • Explain the application of phenol • Explain with the aid of process flow				

	anhydride from naphthalene 2.9 Identify the application of Linear Alkyl Benzene (LAB) 2.10 Identify the feed stocks for LAB production 2.11 Describe the process technology for the production of LAB from kerosene and HF alkylation 2.12 Identify the reaction steps involve in LAB production 2.13 Identify the application of phenol 2.14 Identify different route for phenol production	diagram the technology for the production of phenol from cumene • Mention the application of maleic anhydride • Explain with the aid of process flow diagram the technology for the production of maleic anhydride from benzene • Explain the application of nitrobenzene • Explain with the aid of process flow diagram the technology for the production of nitrobenzene • Explain the application of aniline • Explain with the aid of process flow diagram the				

	2.15 Describe the process technology for the production of phenol from cumene 2.16 Identify the reaction steps involve in phenol production from cumene 2.17 Identify the application of maleic anhydride 2.18 Describe the process technology for the production of maleic anhydride from benzene 2.19 Identify the reaction steps involve in the production of maleic anhydride 2.20 Identify the	technology for the production of aniline from benzene. • Explain the application of aniline				

	application of nitrobenzene 2.21 Describe the process technology for the production of nitrobenzene from benzene 2.22 Identify the reaction steps involve in the production of nitrobenzene 2.23 Identify the various important chemicals obtainable from nitrobenzene 2.24 Identify the application of aniline 2.25 Describe the process technology for the production of aniline from benzene 2.26 Identify the reaction steps					

	involve in the production of aniline.					
General Objective 3.0: Appreciate the process technology for production of Polymers						
7-10	3.1 Explain the importance of polymers in petrochemical industry 3.2 Identify various common polymers and their application 3.3 Define polydispersity index 3.4 Differentiate between homopolymer and copolymer 3.5 Identify basic molecular structures of polymers 3.6 Present the classification of polymers on the basis of physical properties	• Explain the relevance of polymers in petrochemical industry • With the aid of chart depict common polymers and their application • Explain polydispersity index • Sketch the basic molecular structures of polymers • With the aid of a chart discuss the classification of polymers • With examples differentiate between thermoplastic	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	Sketch the basic molecular structures of polymers

	3.7 Distinguish between thermoplastic and thermosetting polymer 3.8 Differentiate between addition and condensation polymerization 3.9 Identify the importance of polyethylene in petrochemical industry 3.10 Identify the major types of polyethylene 3.11 Explain the evolution of high pressure polymerization of ethylene 3.12 Identify commercial process technology for the production of polyethylene	and thermosetting polymer • Explain the application of polyethylene in petrochemical industry • Summarize the evolution of high pressure polymerization of ethylene • Explain the Union Carbide Process technology for polyethylene production with the aid of process flow diagram • Mention the importance of polypropylene • Depict the				

	3.13 Describe the Union Carbide Process for polyethylene production 3.14 Identify the importance of polypropylene in petrochemical industry 3.15 Identify the chemical structure of polypropylene 3.16 Identify commercial process technology for the production of polypropylene 3.17 Describe the Union Carbide Process (UNIPOL) for polypropylene production 3.18 Explain the evolution of the Zeigler-Natta catalyst used in	chemical structure of polypropylene • Explain the Union Carbide Process (UNIPOL) • Identify the application of Zeigler-Natta catalyst • Explain the importance of polyvinyl chloride (PVC) in petrochemical industry • Describe with the aid of process flow diagram the suspension polymerization technology for the production of PVC • Mention the importance of polystyrene in petrochemical industry				

	polymerization of olefins 3.19 Identify the importance of polyvinyl chloride (PVC) in petrochemical industry 3.20 Identify commercial process technologies for the production of PVC 3.21 Describe suspension polymerization for the production of PVC 3.22 Identify the importance of polystyrene in petrochemical industry 3.23 Describe polystyrene production by bulk polymerization	• Describe with the aid of process flow diagram for polystyrene production by bulk polymerization				

General Objectives 4.0: Appreciate the process technology for production of Elastomers and Polyurethanes						
11	4.1 Explain the important application of Elastomers (rubber) 4.2 Differentiate between natural and synthetic rubber 4.3 Explain the application of styrene butadiene rubber (SBR) 4.4 Describe emulsion polymerization for the production of SBR 4.5 Explain the application of polybutadiene 4.6 Describe the process technology for the production of polybutadiene	• Mention the importance of rubber in petrochemical industry • With the aid of chart identify major derivative from natural and synthetic rubber • Mention the application of styrene butadiene rubber (SBR) • Mention the application of polybutadiene • Depict the process technology for the production of polybutadiene • Mention application of nitrile rubber • Depict the process	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	Differentiat e between natural and synthetic rubber

	4.7 Explain the application of nitrile rubber 4.8 Describe the process technology for the production of nitrile rubber 4.9 State the application of ethylene vinyl acetate (EVA) 4.10 Describe the process technology for the production of EVA	technology for the production of nitrile rubber • Mention application of EVA • Depict the process technology for the production of EVA				
General Objective 5.0 Know the process technology for production synthetic fiber						
12-13	5.1 State the relevance of synthetic fibers to petrochemical industry 5.2 Present the classification of fiber 5.3 List petrochemical	• Mention the relevance of synthetic fibers to petrochemical industry • Depict with the aid chart the classification of fiber	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	List petrochemical obtainable from synthetic fiber

	obtainable from synthetic fiber 5.4 State the importance of cyclohexane 5.5 Describe process technology for the production of cyclohexane from liquid phase hydrogenation of benzene 5.6 State the importance of caprolactam 5.7 Identify different route for the production of caprolactam 5.8 Describe process technology for the production of caprolactam from cyclohexane 5.9 State the stages involve in the manufacture of caprolactam	• Identify important petrochemical obtainable from synthetic fiber • Mention the application of cyclohexane • Draw the process flow diagram for cyclohexane production technology • Mention important of caprolactam • Draw the process flow diagram for caprolactam production technology • Explain the stages involve in the manufacture of caprolactam • Mention the importance of				

	5.10 State the importance of adipic acid 5.11 Identify different route for the production of adipic acid 5.12 Describe process technology for the production of adipic acid by two step oxidation process 5.13 State the importance of terephthalic acid (TPA) 5.14 Identify different route for the production of TPA 5.15 Describe AMCO process for the manufacture of TPA 5.16 State the importance of	adipic acid • Draw the process flow diagram for the production of adipic acid • Mention the application of TPA • Draw the process flow diagram for the production of TPA by AMCO process technology • Mention the application of acrylonitrile • Explain process technology for the manufacture of acrylonitrile • Mention the application of polyester fiber				

	acrylonitrile 5.17 Identify different route for the production of acrylonitrile 5.18 Describe process technology for the manufacture of acrylonitrile 5.19 State the importance of polyester fiber 5.20 Identify different route for the production of polyester fiber 5.21 Describe process technology for the manufacture of polyester fiber from TPA 5.22 State the importance of acrylic fiber 5.23 Describe process technology for the manufacture of acrylic fiber 5.24 State the	• Explain process technology for the manufacture of polyester fiber from TPA • Mention the application of acrylic fiber • Explain process technology for the manufacture of acrylic fibre • Identify the applications of Nylon 6 and Nylon 66 • Explain process technology for the manufacture Nylon 6 • Explain process technology for the manufacture Nylon 66				

	importance of Nylon 6 and Nylon 66 5.25 Describe process stages involve in the manufacture of Nylon 6 and Nylon 66					

PROGRAMME: HIGHER NATIONAL DIPLOMA HND PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (REFINING OPTION)		
COURSE TITLE: Petroleum Refining Processes II	**Code: PRT 411**	**CH: 2** **CU: 2**
	Pre-requisite:	**Theoretical: 2 Hours/week** **Practical: 0 Hours/week**
Year:2 Semester:2		

Goal: This course is designed to enable the student possess deep understanding of the principles of secondary and finishing petroleum refining processes.

General Objectives:

On completion of the course, the student should be able to:

1.0 Appreciate hydrotreatment process

2.0 Appreciate catalytic reforming process

3.0 Comprehend alkylation process

4.0 Appreciate isomerization process.

5.0 Comprehend the product blending techniques

6.0 Appreciate refinery control of air pollution

7.0 Appreciate refinery noise control

PROGRAMME: HIGHER NATIONAL DIPLOMA HND PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (REFINING OPTION)						
COURSE TITLE: PETROLEUM REFINING PROCESSES II			**Code: PRT 411**		**CH: 2 CU: 2**	
Theoretical Content				**Practical Content**		
General Objective 1.0:Appreciate hydrotreatment processes						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1-3	1.1 Explain the importance of hydrotreatment processes. 1.2 Explain hydrotreatment reactions and operating conditions. 1.3 Describe hydrotreatment processes using PFD. 1.4 Carry out material and energy balance on a typical hydrotreating unit. 1.5 Calculate hydrogen requirement for hydrotreatment of a given feedstock with known sulphur, nitrogen and oxygen contents.	Calculate hydrogen requirement for hydrotreatment of a given feedstock with known sulphur, nitrogen and oxygen contents.	Whiteboard, Marker, Textbooks, Lecture notes, etc.	-	-	Define hydrotreatment. State types of hydrotreatment processes. State purpose and importance of hydrotreatment. State feedstock for hydrotreatment process.

General Objectives 2.0:**Appreciate Catalytic Reforming Process**						
4 - 6	2.1 Explain the importance and applications of catalytic reforming. 2.2 Explain the catalytic reforming reactions. 2.3 Explain the feed preparation techniques for reforming unit. 2.4 List the types of catalytic reforming technologies. 2.5 Explain the process variables in catalytic reforming. 2.6 Describe the thermodynamics of reforming process. 2.7 Explain the reforming catalyst: dual activity, poisoning, preparation, sulfiding, activation, activity, regeneration etc. 2.8 Explain the efficiency of reforming unit. 2.9 Prepare material and energy balance of the typical reformer unit.	Evaluate the yield and efficiency of catalytic reforming process with emphasis to yield and conversion. Carry out material and energy balance around a typical reforming unit.	Whiteboard, Textbooks, Lecture notes, computer, related internet materials and journals.	-	-	Define catalytic reforming process. List types of catalytic reforming technologies. Explain the need for pretreatment before reforming process. Explain why three to four reactors are used in catalytic reforming process, and the need for interstage heating of the reactor

						effluent.
General Objectives 3.0: Comprehend Alkylation Process						
7 - 9	3.1 State the importance of alkylation process. 3.2 Describe the alkylation reactions. 3.3 State the alkylation products and their areas of utilization. 3.4 Describe alkylation catalysts, effects of impurities on their activity. 3.5 Describe Hydrofluoric Acid (HF), Sulphuric Acid (H_2SO_4) and Ionic Liquid alkylation processes. 3.6 Prepare material and energy balance of the alkylation processes.	Draw PFD of HF, $H_2SO_4$and Ionic liquid Alkylation unit. Perform material and energy balance for alkylation process. .	Whiteboard, Marker, Textbooks, Journals, etc	-	-	State the importance of alkylation process. List the types of alkylation process. Describe alkylation products and their areas of utilization.
General Objectives 4.0: Appreciate isomerization process.						
10 - 11	4.1 Define isomerization process. 4.2 Distinguish between catalytic reforming and catalytic isomerization. 4.3 Describe types of isomerization.	Draw PFDs of Butane and light naphtha isomerization processes Carry out material and energy balance of a typical isomerization process.	Whiteboard, Markers, Textbooks, Lecture notes, Journals, etc.	-	-	Define isomerization. Distinguish between catalytic reforming and

	4.4 State the feed requirements for isomerization processes. 4.5 Describe the isomerization Catalysts, their type, activity, deactivation and regeneration. 4.6 Describe typical Butane and light naphtha isomerization processes. 4.7 Prepare material and energy balance of a typical isomerization unit.					catalytic isomerization. State the feed requirement for butane and light naphtha isomerization. Mention types of isomerization catalyst.
General Objectives 5.0 Comprehend product blending techniques						
12 - 13	5.1 Explain the objectives of product – Blending. 5.2 Explain the basic equation utilized for single property blending. 5.3 Explain the basic principles of linear programming and its applications in multi-property blending.	Describe the basic equation utilized for single property blending. Calculate the amount of n-butane required to achieve set RVP for gasoline blending. Calculate the RON and MON of	Whiteboard, Markers, Textbooks, Lecture notes, Journals, etc.	-	-	State the objectives of product blending. Define flash point. Define RON

	5.4 Calculate the amount of n-butane required to achieve set Reid Vapor Pressure (RVP) for gasoline blending. 5.5 Calculate the Research Octane Number (RON) and Motor Octane Number (MON) of blended gasoline sample. 5.6 Calculate the flash points and viscosities of individual fuel oil fractions and their blend. 5.7 Calculate the optimum amount of blending components to achieve set properties using graphical techniques and linear programming techniques.	individual gasoline fractions and their blend.				and MON, and state their relevance in motor gasoline engine.
General Objectives 6.0 Appreciate refinery control of Air pollution						
14	6.1 Explain Refinery Air Pollution.	Describe techniques for refinery air	Textbooks, journals,	-	-	Define air

	6.2 Enumerate Techniques of Air Pollution Control. 6.3 Identify sources of Air pollution in refineries. 6.4 Describe strategies for refinery air pollution control.	pollution control.	internet materials.			pollution. Explain a typical in-plant air pollution control techniques.
General Objective 7.0 Appreciate refinery noise control						
15	7.1 Explain noise and its harmful effects. 7.2 Describe strategies for noise control in refineries. 7.3 Describe the techniques being followed to design a noise free equipment.	Describe the use of earmuff and padded wall.	Textbooks, journals, internet materials, etc.	-	-	Define noise. State the effects of noise. State the function of earmuff.

YEAR 2 SEMESTER 2

PROGRAMME: HIGHER NATIONAL DIPLOMA HND IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (GAS PROCESSING OPTION)		
COURSE TITLE: Process Safety and Environmental Control	**Code: PGP 421**	**CH: 2 CU: 2**
	Pre-requisite:	**Theoretical: 2 Hours/week**
Years: 2 Semester: 2		**Practical: 0 Hours/week**

GOAL: This course is designed to provide students with the knowledge required in process safety, environment and control.

1.0	Comprehend the legislation relevant to health and safety at work and the application of common law to environmental safety and sanitation
2.0	Comprehend the importance of industrial relations, team spirit and the role of joint consultation and safety committees
3.0	Appreciate the importance of good health and safety in working environment
4.0	Appreciate the importance of incident reporting in accident prevention
5.0	Comprehend process safety management (PSM)
6.0	Comprehend critical safety equipment control.
7.0	Comprehend fire hazards and Control.
8.0	Comprehend air pollution in the oil and gas industry
9.0	Comprehend water pollution in the oil and gas industry.
10.0	Appreciate industrial solid waste management.
11.0	Comprehend potable water treatment processes.

PROGRAMME: HIGHER NATIONAL DIPLOMA HND IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (GAS PROCESSING OPTION)						
COURSE TITLE: Process Safety and Environmental Control			**Course Code: PGP 421**		**CH:2 CU:2**	
Theoretical Content			**Practical Content**			
General Objective 1.0: Comprehend the legislation relevant to health and safety at work and the application of common law to environmental safety and sanitation						
week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1 - 2	1.1 Explain the main provision of the health and safety work act. 1.2 Explain the main provisions of the factories act as regards fire precautions. 1.3 State the relevance of common laws to health and safety at work. 1.4 Identify the general duties and responsibilities of employers and others in the control of health and safety at work. 1.5 Describe the roles and functions of executives, the inspectorate and other enforcing authorities in safety at work. 1.6 Explain the elements of health and safety management system (HSMS) 1.7 Explain the principles of developing effective safety policy.	Explain the health and safety legislation. List the duties of employers and employees under the health and safety at work act.	White board computer, recommended textbooks, lecture note and related journals	-	-	List the duties of employers and employees under the health and safety at work act.
General Objective 2.0: Comprehend the importance of industrial relations, team spirit and the role of joint consultation and safety committees						
3	2.1 Describe the importance of industrial relation in establishing effective safety arrangements 2.2 Describe the roles of joint consultation, safety representatives and safety committee.	Explain the importance of industrial relation, joint consultation and safety	White board computer, recommended textbooks,	-	-	Explain the roles of joint consultation, safety representativ

	2.3 Explain the committee procedures including the role of chairman, members, agenda and paper in safety planning.	committee	lecture note and related journals			es and safety committee.
General Objective 3.0: Appreciate the importance of good health and safety in working environment						
4 - 5	3.1 Explain the need for accident prevention 3.2 Explain **t**he psychological basis for accident prevention. 3.3 Explain **t**he economic basis of accident prevention 3.4 Explain the legal basis of accident prevention. 3.5 Explain categories of potential causes of physical injuries and occupational illnesses in working place. 3.6 Explain the preventive and protective measures (hierarchy of hazards control). 3.7 Identify different safety signs in the workplace. 3.8 Explain personal protective equipment. 3.9 Explain the permit to work systems 3.10 Identify the sources of information and materials needed in cases of emergency. 3.11 Explain first aid requirement	Explain the psychological, economic and legal basis of accident prevention. Explain methods of hazard control, safety signs and personal protective equipment	White board computer, recommended textbooks, lecture note and related journals	-	-	Explain the legal basis of accident prevention.
General Objective 4.0: Appreciate the importance of incident reporting in accident prevention						
6	4.1 Explain the uses of reports in accident prevention 4.2 List main elements of oral and written reports and their purpose. 4.3 Explain the use of statistical data e.g. accident incidence, frequency rate in planning prevention of accident	Explain the importance of incident reporting	White board computer, recommended textbooks, lecture note and	-	-	List the typical contents of incident report

	4.4 Apply statistics to the quantitative assessment of risk.		related journals			
General Objective 5.0: Comprehend process safety management (PSM)						
7 - 8	5.1 State the differences between process safety, occupational health and personal safety 5.2 Explain process safety related incidents. 5.3 Explain process safety management and process safety legislations. 5.4 Describe the elements of process safety management. 5.5 Explain process hazard analysis (PHA) 5.6 List methods used in process hazard analysis 5.7 Explain hazard identification, risk assessment, and control measures in process plant 5.8 Carry out hazard and operability study (HAZOP) using process safety data 5.9 Carryout failure mode and effects analysis (FMEA) using process safety data 5.10 State guidelines on internal safety audits (procedures and checklist)	Explain activities in 5.1 to 5.10	White board computer, recommended textbooks, lecture note and related journals	-	-	Explain process safety related incidents.
General Objective: 6.0 Comprehend critical safety equipment control						
9	6.1 Mention critical safety equipment. 6.2 Explain the importance of critical safety equipment 6.3 Explain emergency shutdown systems	Describe critical safety equipment and emergency shutdown systems.	White board, computer, Related software,	-	-	List critical safety equipment.

	6.4 Describe components of emergency shutdown system		projector, textbooks, Lecture note and related journals			
General Objective 7.0: Comprehend fire hazards and control						
10	7.1 Explain basic principles of fire spread. 7.2 Explain classes of fire spread. 7.3 Explain methods of fire spread. 7.4 Explain types of explosions 7.5 Identify sources of ignition in the petroleum and petrochemical plants. 7.6 Explain control measures to minimize the effects of fire and explosion in the petroleum and petrochemical plants.	Describe fire explosions. List methods of minimizing the effects of fire and explosions.	White board, recommended textbooks, lecture note, related journals Internet materials, computer related software.	-	-	State the different type of fire protection equipment used in the oil and gas industry.
General Objective 8.0: Comprehend Air pollution in the oil and gas industry.						
11 - 12	8.1Explain air quality standards. 8.2 Explain Green House Gases (GHG). 8.3 State the sources of air pollution in petroleum processing industry 8.4 State the sources of air pollution in petrochemical plants 8.5 Explain air pollution abatement and control techniques. 8.6 Explain the environmental and health impact of Air pollution**.**	Describe the effect of air pollution.	White board, Recommended textbooks, Lecture note computer related software, internet related material and related journals	-	-	Explain air pollution abatement and control techniques.

13	**General Objectives 9.0 Comprehend water pollution in the oil and gas industry** 9.1 Identify the sources of industrial water. 9.2 Explain water quality standards. 9.3 Identify the sources of wastewater in process plants. 9.4 Describe wastewater treatment and disposal 9.5 Describe environment health consequences of water pollution.	Describe the sources of industrial water in refinery	White board, recommended textbooks, lecture note and related journals	-	-	Describe the effect of water pollution
General objective 10.0: Appreciate Industrial Solid Waste Management						
14	10.1 Identify sources of solid waste in petroleum and petrochemical plants 10.2 Describe solid waste management and disposal 10.3 Identify the environmental and health consequences of solid wastes	Explain activities in 10.1-10.3	White board computer, recommended textbooks, lecture note and related journals	-	-	Describe solid waste management and disposal
General objectives 11.0: Comprehend Potable Water Treatment Processes						

15	11.1 Identify sources of potable water and its applications 11.2 State potable water quality requirements 11.3 Identify sources of potable water contaminants 11.4 Describe potable water treatment 11.5 Explain potable water quality monitoring	Explain activities in 1.1-11.5	White board, recommended textbooks, lecture notes and related journals	**-**	**-**	List the sources of potable water

PROGRAMME: HIGHER NATIONAL DIPLOMA IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (PETROCHEMICAL AND POLYMER OPTION)		
Course Title: Process Integration and Optimization	**Course Code: PGP 422**	**Credit Hour: 2** **Credit Unit: 2**
	Pre-requisite: NIL	**Theoretical: 2 Hours/week**
Year: 2 Semester: 1		**Practical: 0 Hours/week**

Goal: This course is intended to provide students with the knowledge and skills required in using available optimization techniques and tools to minimize resources and maximize benefits during design and operations of chemical process plants

General Objectives:

On completion of this course, the students should be able to:

1. Appreciate the basic concepts of chemical process optimization
2. Formulate chemical process optimization model
3. Comprehend unconstrained single variable optimization methods and applications
4. Comprehend unconstrained multivariable optimization methods
5. Formulate and solve linear programming problems using simplex algorithm
6. Formulate and solve dynamic programming problems
7. Formulate and solve constrained/unconstrained nonlinear programming models

8. Apply optimization techniques in chemical process equipment design
9. Appreciate the use of software tools for solving process optimization problems
10. Apply the integrated planning, scheduling and control in the processing industries.

PROGRAMME: HIGHER NATIONAL DIPLOMA IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (PETROCHEMICAL AND POLYMER OPTION)						
Course Title: Process Integration and Optimization			**Course Code: PGP 422**		**CH: 2 CU: 2**	
Theoretical Content				**Practical Content**		
General Objective: 1.0 Appreciate the basic concepts of chemical process optimization						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1	1.1 Explain the Principle of process optimization 1.2 Describe Functions and functionals 1.3 Identify Maxima and minima 1.4 Classify of stationary points	Use graph to identify stationary points	Textbooks, journals, internet materials.	-	-	Define optimization
General Objectives: 2.0 Formulate chemical process optimization model						
2	2.1 Classify engineering	Develop simple optimization models	Textbooks, journals, internet	-	-	Classify optimization models in engineering

	models 2.2 Develop Models for Optimization 2.3 Analyze optimization models 2.4 List models for engineering decision making in design and operations		materials.			Develop simple model for optimization
General Objectives: 3.0 Comprehend unconstrained single variable optimization methods and applications						
3	3.1 Classify mathematical models 3.2 Describe Single variable unconstrained models 3.3 Describe optimization methods for unconstrained models 3.4 Explain the application of unconstrained single variable	Explain single variable unconstrained optimization models	Textbooks, journals, internet materials.	-	-	State examples of single variable unconstrained models in petrochemical process industry.

	optimization					
General Objectives: 4.0 Comprehend unconstrained multivariable optimization methods						
4	4.1 Explain multivariable unconstrained models 4.2 Describe optimization methods for multivariable unconstrained models 4.3 Explain the application of multivariable unconstrained optimization	Develop and explain multivariable unconstrained optimization models	Textbooks, journals, internet materials	-	-	State examples of multivariable unconstrained models in petrochemical process industry

General Objectives: 5.0 Formulate and solve linear programming problems using simplex algorithm						
5 - 6	5.1 Explain Linear Programming (LP) model 5.2 State the standard form of linear programming model 5.3 Apply graphical method for solving two variable optimization problem 5.4 Construct Simplex table using Simplex algorithm 5.5 Explain Simplex criterion in minimization versus maximization problems 5.6 Explain Duality	Explain with examples linear programming model Solve problems on linear programming model	Textbooks, journals, internet materials, computer with MS Excel or MATLAB, Projector.	-	-	State the conditions for a linear programming model Use simplex algorithm to solve a linear programming problem

	in LP 5.7 Carry-out sensitivity or post optimality analysis 5.8 List other algorithms for solving LP problems					
General Objectives: 6.0 Formulate and solve dynamic programming problems						
7 -8	6.1 Explain Dynamic Programming (DP) models 6.2 Demonstrate how to represent multistage decision process in a diagram 6.3 Identify the types of multistage decision problems 6.4 Explain the concept of sub optimization and the principle of optimality 6.5 State recursive equations – forward and backward	Explain Dynamic Programming (DP) models Solve problems on dynamic programming model	Textbooks, journals, internet materials, materials, computer with MS Excel or MATLAB, Projector.	-	-	State the difference between dynamic and linear programming model

	recursions 6.6 Explain computational procedure in dynamic programming 6.7 State the applications of Dynamic Programming in chemical process industry					
General Objectives: 7.0 Formulate and solve constrained/unconstrained nonlinear programming models						
9 - 10	7.1 Describe how to formulating nonlinear optimization problems 7.2 State nonlinear objective functions and constraints 7.3 Explain Methods of solving Nonlinear Optimization Problems 7.4 Solve Nonlinear Programming Problems with only equality constraints 7.5 Solve Nonlinear	Explain constrained/unconstrained nonlinear programming models Solve problems on equality constrained/unconstrained nonlinear programming models	Textbooks, journals, internet materials, computer with MS Excel or MATLAB, Projector.	-	-	State the methods used in solving nonlinear programming problems

	Programming Problems with only inequality constraints 7.6 Solve Nonlinear Programming Problems with both equality and inequality constraints 7.7 Identify the applications and Examples of Nonlinear Programming in chemical process industry					
General Objectives: 8.0 Apply optimization techniques in chemical process equipment design						
11	8.1 Carry-out optimization of reactor design and operation 8.2 Carry-out optimization of separation process equipment design (distillation, absorption, extraction, adsorption etc.) 8.3 Carry-out optimization of	Discuss the application of optimization techniques in design of process equipment	Textbooks, journals, internet materials, computer with MS Excel or MATLAB, Projector.	-	-	State the model and develop algorithm for optimization of a named process equipment

	design of heat transfer equipment (heat exchanger, condenser, reboiler, fired heater, cooling tower etc.) 8.4 Carry-out optimization of fluid flow systems					
General Objectives: 9.0 Appreciate the use software tools for solving process optimization problems						
12 - 13	9.1 Use Microsoft Excel to solve process optimization problems. 9.2 Use application software such as ASPEN HYSYS, MATLAB, ChemCAD etc to solve process optimization problems	Describe the use of Microsoft Excel, ASPEN HYSYS, MATLAB, ChemCAD etc for solving process optimization problems.	computer with MS Excel, MATLAB, or ASPEN HYSYS, Projector.	-	-	Solve process optimization problems using ASPEN HYSYS, MATLAB, Microsoft Excel etc.

General Objectives 10.0: Apply the integrated planning, scheduling and control in the processing industries						
14 - 15	10.1 Explain the five optimization levels in process industry i.e.: - Planning - Scheduling - Optimization - Control - Monitoring 10.2 Explain supply chain in process industry 10.3 Explain a typical refinery planning and scheduling 10.4 Explain process monitoring and analysis. 10.5 List examples of error arising from inaccurate measurements	• Illustrate a schematic diagram of the hierarchy of optimization level • Depict with the aid of flow diagram, supply chain in a process industry • Solve a typical refinery planning and scheduling optimization problem. • Explain the steps taken to improve data accuracy	Recommended textbooks, Internet services, etc. White Board, Multimedia projector	-	-	Explain supply chain in process industry

Programme: HIGHER NATIONAL DIPLOMA IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY		
Course Title: PROCESS AND EQUIPMENT DESIGN	**Code: PGP 423**	**Credit Hour: 2** **Credit Unit: 2**
	Pre-requisite: Nil	**Theoretical: 2 hours/week**
Year: 2 Semester: 2		**Practical : hours/week**

Goal: This course is designed to provide students with knowledge and skills required for data collection and process equipment design

General Objectives: On completion of this course, the student should be able: -

1.0 Comprehend literature survey and design information.

2.0 Appreciate process calculations.

3.0 Appreciate flowsheets.

4.0 Appreciate Process Costing.

5.0 Appreciate equipment design and specifications.

6.0 Comprehend economic analysis of designs

Programme: HIGHER NATIONAL DIPLOMA IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY						
Course Title: PROCESS AND EQUIPMENT DESIGN			**Code: PGP 423**		**CH: 2 CU:2**	
Theoretical Content			**Practical Content**			
General Objective 1.0 :Comprehend literature survey and design information						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1-2	1.1 Explain Design data collection 1.2 Develop a chemical process. 1.3 Select appropriate unit process/unit operations for the production process	Explain activities in 1.1 to 1.3	White board, Textbooks, related software, journals, internet materials, etc	-	-	Explain the procedure for developing a chemical process
GENERAL OBJECTIVE 2.0:Appreciate process calculations						
	2.1 Carryout material and energy balance. 2.2 Specify all major equipment.	Solve typical problem involving material and energy balance	White board, Textbooks, related software, journals, internet materials, etc	-	-	Carryout material and energy balance for a given process
GENERAL OBJECTIVE 3.0:Appreciate flow sheets						
	3.1 Draw a Process Flow Diagram (PFD) 3.2 Draw flow diagram for material and energy balance.	Draw a Process and Instrumentation Diagram (P&ID) of a	White board, Textbooks, related software, journals,	-	-	Show major control loops and instrumentation on the a typical PFD

	3.3 Indicate major control loops and instrumentation on the process.	typical process	internet materials, etc			
GENERAL OBJECTIVE 4.0:Appreciate process costing						
	4.1 State procedure for process analysis. 4.2 Explain the financial viability of processes.	Explain activities in 4.1 to 4.2	White board, Textbooks, related software, journals, internet materials, etc	-	-	Explain the procedure for evaluatingfinancial viability of a process
GENERAL OBJECTIVE 5.0: Appreciate equipment design and specifications						
	5.1 Select the appropriate method for the design of equipment. 5.2 Determine the data necessary for the design of equipment. 5.3 Determine the size and configuration of the equipment. 5.4 Select the most appropriate internals for equipment. (e.g. trays, packing, etc. 5.5 Select the most appropriate instrumentation and controls for equipment under design. 5.6 Prepare dimensional sketches suitable for submitting detailed design of components.	Explain activities in 5.1 to 5.6	White board, Textbooks, related software, journals, internet materials, etc	-	-	Calculate size of typicalprocess equipment.

GENERAL OBJECTIVE 6.0:Comprehend economic analysis of designs						
	6.1 Prepare an equipment schedule listing major equipment and giving sizes, capacity, operating conditions and material of construction. 6.2 Evaluate cost of individual equipment 6.3 Select plant layout and site for plant locations. 6.4 Prepare economic analysis. 6.5 Prepare a design report.	Explain activities in 6.1 to 6.5	White board, Textbooks, related software, journals, internet materials, etc	-	-	Evaluate cost of individual equipment

Programme: (Higher National Diploma) Petrochemical and Gas Processing Engineering (Petrochemical and Gas Processing Option)		
Course Title: Power Plant and Energy Integration	**Code: PGP 424**	**Credit Hour: 2** **Credit Unit:2**
	Pre-requisite:	**Theoretical: 2 hours/week**
Year: 2 Semester: 3		**Practical 0 : hours/week**

Goal: This course is designed to enable students to acquire the general knowledge on power plant engineering

General Objectives: On the completion of the course, the student should be able to:

1.0 Appreciate basics of power plant thermodynamics
2.0 Appreciate concept ofpower plant cycle analysis
3.0 Appreciate basics of combustion processes
4.0 Comprehend fundamentals of steam generator
5.0 Comprehend **basics of steam turbine**
6.0 Comprehend **basics of steam cycle heat exchangers**
7.0 Comprehend fundamental of water treatment and circulating system in power plant
8.0 Appreciate fundamentals of gas turbines
9.0 Comprehend basics of nuclear power plant
10.0 Appreciate fundamentals of renewable energy resources and their conversion technologies.

Programme: (Higher National Diploma) Petrochemical and Gas Processing Engineering (Petrochemical and Gas Processing Option)						
Course Title: Power Plant and Energy Integration				**Code: PGP 424**		**CH: 2 CU:2**
Theoretical Content				**Practical Content**		
General Objective 1.0 : Appreciate the basics of power plant thermodynamics						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1-3	1.1 Define thermodynamics	• Briefly explain the relevance of thermodynamics to	Recommended textbooks,	-	-	Describe Heat Engine.

	1.2 Explain the following properties: • Temperature • Pressure • Specific volume • Work and Heat • Internal Energy and enthalpy • Specific heat 1.3 Explain first and second law of thermodynamics 1.4 Describe control mass and control volume 1.5 Describe the different states of water as a compressible fluid 1.6 Explain ideal and real gas equations 1.7 Describe Heat	useful work • Explain a simple experiment that illustrate the thermodynamic properties of water • Illustrate pistil and cylinder experiment for converting thermal to mechanical energy	Internet services, etc. White Board, Multimedia projector			

	Engine.					
General Objective 2.0: Appreciatethe concept of power plant cycle analysis						
4-6	2.1 Describe Rankine cycle 2.2 Differentiate between basic, open and close loop Rankine cycle 2.3 Determine the efficiency of Rankine cycle using steam table 2.4 Carry out a simple heat balance calculations on a Rankine cycle 2.5 Calculate the efficiency of turbine along expansion lines 2.6 Describe Brayton cycle. 2.7 Explain analysis calculation of an air-standard cycle.	• Draw the schematic diagram of a Rankine cycle • Show with the aid of T-s diagram ways to improve the efficiency of Rankine cycle • Draw the schematic diagram of a Brayton cycle	Recommended textbooks, Internet services, etc. White Board, Multimedia projector	-	-	Differentiate between basic, open and close loop Rankine cycle
General Objectives 3.0: Appreciate the basics of combustion processes						
7-9	3.1 Explain combustion	Explain activities in 3.1 to 3.8	Recommended textbooks,	-	-	Explain boiler efficiencycalc

	process from theoretical and practical perspective 3.2 Explain the criteria required for combustion reaction to take place 3.3 Describe the characteristics of conventional fuels used in power plants (a) Natural gas (b) Fuel oil (c) Coal 3.4 Explain the following terms: (a) Mole (b) Heating value (c) Stoichiometric air (d) Excess air 3.5 Calculate the stoichiometric and excess amount of air required for the combustion of a given amount of fuel 3.6 Explain the		Internet services, etc. White Board, Multimedia projector			ulations using input-output method and heat-loss method

	constituents of flue gas 3.7 Explain boiler efficiency calculations using input-output method and heat-loss method 3.8 Explain the relationship between steam generator performances and design/operatin g parameters.					
General Objectives 4.0: Comprehend the fundamentals of steam generator						
10-12	4.1 Explain the evolution of steam generator 4.2 Explain the principal components of a steam generator 4.3 Describe the function of a furnace 4.4 Explain working principle of a fired-tube boiler	• Draw a well labelled schematic diagram of a typical modern steam generator • Explain the operation of a furnace • Explain the process of heat recovery in fired-tube boiler with the aid of a schematic flow diagram • Explain the	Recommended textbooks, Internet services, etc. White Board, Multimedia projector	-	-	Explain working principle of a fired-tube boiler

	4.5 Distinguish between corner and wall fired-tube boiler 4.6 Explain working principle of water-tube boiler 4.7 Explain absorption of heat in water-tube boiler 4.8 Distinguish between natural and forced circulation of water in water-tube boilers 4.9 Describe the function of a steam drum in a boiler 4.10 Describe the operation of boiler circulating pump	process of heat recovery in water-tube boiler with the aid of a schematic flow diagram • Explain the difference between super heater and reheater • Explain the meaning of overall heat transfer coefficient • Show the configuration of a typical Air-heater • Show Steam air preheating coils flow diagram • Write the equation for calculating ACET • Draw a schematic diagram showing the configuration of a Soot Blower • Describe the working principle of a coal feeder • Show the configuration of ball mill (pulveriser)				

	4.11 Describe an economizer and evaluate the overall heat transfer coefficient 4.12 Describe superheater and evaluate the overall heat transfer coefficient 4.13 Describe a reheater and evaluate the overall transfer coefficient 4.14 Explain the function of air-heater 4.15 Explain the importance of Air-preheater coil 4.16 Define average cold end temperature (ACET) 4.17 State the	• Illustrate the working principle of a coal burner				

	function of soot blower 4.18 Explain the function of a coal feeder 4.19 List the different types of coal pulverizes 4.20 State the function of ignitors and warmup burners. 4.21 State the function of Ductwork, Ash Hoppers, and Dampers in steam generator.					
General Objectives 5.0: Comprehend the basics of steam turbine						
13-15	5.1 Explain the evolution of steam turbine 5.2 Describe	Explain activities in 5.1 to 5.13	Recommended textbooks, Internet services, etc.	-	-	State the function of each components of a typical

	configuration and applications of a steam turbine 5.3 State the function of each components of a typical steam turbine 5.4 Explain the working principle of a steam turbine 5.5 Differentiate between impulse and reaction turbine stages in steam expansion 5.6 Explain the conversion of mechanical energy on the turbine shaft to electrical energy in generator rotor 5.7 Explain the function of the major components of a generator 5.8 Explain different configurations of steam turbine shaft 5.9 Explain the		White Board, Multimedia projector			steam turbine

	component of a rotor assembly 5.10 Distinguish between turbine arrangement in fossil and nuclear power plants 5.11 Explain the functions of auxiliary components of steam turbine 5.12 Describe steam generator cooling and purge systems. 5.13 Explain the function of the following control systems in steam turbine generator • Turbine governor • Trip system • Excitation system • Supervisory instrumentation system.					
General Objective 6.0: Comprehend the basics of steam cycle heat exchangers						
	6.1 Explain the function and parts of a typical condenser	• With example illustrate calculation of typical condenser	Recommended textbooks, Internet	-	-	Distinguish between open and close heater

	6.2 Describe different flow configuration of a typical condenser 6.3 Evaluate the following condenser design parameters: • Head load • No. of passes • Tube diameter • Tubes surface area • Effective number of tubes • Circulating water pressure drop 6.4 Explain the function and parts of a typical heater 6.5 Distinguish between open and close heater designs.	design parameters. • With example illustrate the determination of typical heater design parameters	services, etc. White Board, Multimedia projector			designs
General Objective 7.0: Comprehend the fundamental of water treatment and circulating system in power plant						
	7.1 Explain the purpose of feed-water treatment in power plant 7.2 Identify sources of water supply to	• Explain the reason for water treatment in power plant • Enumerate the	Recommended textbooks, Internet services, etc.	-	-	Explain the working principle of cross flow hyperbolic natural draft cooling

	power plant 7.3 Summarize common characteristics of natural waters 7.4 Identify dissolved minerals found in natural waters 7.5 Explain alkalinity of water 7.6 Explain the use and requirement of various cooling water grades: (a) Main steam cycle cooling water (b) Auxiliary cooling water (c) Service water (d) High purity water 7.7 Describe the various processes in water treatment: (a) Aeration (b) Settling (c) Coagulation (d) Softening (e) Filtration (f) Demineralization 7.8 Explain the purpose	various sources of water • Identify the characteristic of water • Explain the important of circulating water system • Mention the function of various elements of CWS • Sketch different configuration of pump • Describe the working principle of cooling tower • Describe traveling screen and passive screen • Describe	White Board, Multimedia projector			tower.

	of cooling water system (CWS) 7.9 Explain the function of the following components of CWS: • Condenser • Cooling tower • Water pumps • Water piping • Intake screen 7.2 Distinguish between traveling screen and passive screen 7.3 Differentiate between induced draft and forced draft counter flow cooling towers. 7.4 Explain the working principle of cross flow hyperbolic natural draft cooling tower.	different type of cooling tower designs				

General Objective 8.0: Comprehend the fundamentals of gas turbines						
	1.1 Explain the application of a gas turbine 1.2 Explain the advantages of turbine power plant over coal-fueled power plant 1.3 Explain conventional and nonconventional fuels used in gas turbine power plant 1.4 Explain the function of the major components of a gas turbine power plant: a) Inlet air system b) Compressor c) Combustion section d) Turbine e) Exhaust system Gas starting system 1.5 Explain auxiliary components of gas turbine power plant and state their function	• Draw a typical open-cycle gas turbine and explain its operation • Draw Air-standard Brayton cycle gas turbine and explain its operation • Draw simple cycle configurations of a gas turbine and explain its operation. • Sketch the a section of a typical gas turbine assembly showing major components	Recommended textbooks, Internet services, etc. White Board, Multimedia projector	-	-	Explain environment al concern associated with gas turbinepower plant

	1.6 Explain gas turbine control system 1.7 Explain the operation ofair-standard Brayton cycle 1.8 Define the thermal efficiency of the Brayton cycle 1.9 Describe the working principle of a simple cycle gas turbine 1.10 Distinguish between gas turbine and steam turbines 1.11 Explain cogeneration 1.12 Explain the advantages of gas turbine-based power plant over coal-fueled power plant 1.13 Explain performance parameters of a gas turbines generator 1.14 Explainfactors that influence performance of a					

	gas turbine generator 1.15 Explain the concept of performance degradation in gas turbines generator 1.16 Explain environmental concern associated with gas turbine power plant 1.17 Explain the methods of emission reduction and control.					
General Objective 9.0: Comprehend the basics of nuclear power plant						
	1.1 Explain the concept of fission reaction 1.2 Explain the working principle of a nuclear reactor 1.3 Explain the difference between light and heavy water nuclear reactors 1.4 Explain uranium fuel cycle 1.5 Explain the	• Illustrate with the aid of a diagram, a simple nuclear reactor	Recommend ed textbooks, Internet services, etc. White Board, Multimedia projector	-	-	Explain the working principle of a nuclear reactor

	nomenclature of a typical nuclear reactor components 1.6 Explain electricity generation in nuclear power plant.					
General Objective 10: Appreciate the fundamentals of renewable energy resources and their conversion technologies						
	10.1 Explain renewable energy and enumerate its various sources. 10.2 DescribeSolar Photovoltaic System 10.4 Explain the difference between flat plate and concentrating systems configurations of PV systems 10.5 Explain the difference between parabolic trough, central receiver and parabolic dish solar thermal electric generators 10.6 Explain the difference between vertical and horizontal axial	• Describe photovoltaic technology • Explain solar thermal technology • Explain wind turbine technology • Describe geothermal technology • Show a schematic illustration of an ocean thermal energy conversion (OTEC) • Explain	Recommend ed textbooks, Internet services, etc. White Board, Multimedia projector	-	-	Explain the differencebetw een parabolic trough, central receiver and parabolic dish solar thermal electric generators

	wind turbine 10.7 Explain various biomass energy production technology 10.8 Explain various geothermal energy recovery technology 10.9 Explain battery energy storage technology 10.10 Describe compressed air energy storage (CAES) technology 10.11 Explain fusion energy technology 10.12 Explainmagnetic confinement technology	biomass to energy technology • Explain various energy storage technology • Show a schematic of compressed air energy storage system • Show schematic of magnetic confinement system				

Option).		
Course Title: Advanced Gas Processing Technology II	**Code: GPT 421**	**Credit Hour: 2** **Credit Unit: 2**
	Pre-requisite:	**Theoretical: 2 hours/week**
Year: 2 Semester: 2		**Practical : 0 hours/week**

Goal: This course is designed so as to advance the student's knowledge of natural gas processing technology in order to equip them to operate gas plants and solve common problems that may be encountered.

General Objectives: On the completion of the course, the student should be able to:

1.0 Appreciate the Capital Costs of Gas Processing Facilities.

2.0 Describe Natural Gas Processing Plants.

3.0 Appreciate natural gas liquefaction Process

4.0 Describe Liquefied Natural Gas

5.0 Apply design concepts in industrial processing of natural gas

6.0 Comprehend the transportation and storage of natural gas

Programme: (Higher National Diploma) in Petroleum and Gas Processing Engineering (Petrochemical and Gas Processing

Option).						
Course Title: Gas Processing Technology II			**Code: GPT 421**		**CH: 2**	**CU: 2**
Theoretical Content			**Practical Content**			
General Objective 1.0 : Outline the Capital Costs of Gas Processing Facilities						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1-3	1.1 Describe the basic premises for all plant component cost data. 1.2 Describe Amine Treating. 1.3 Explain glycol dehydration. 1.4 Explain NGL recovery with straight refrigeration (low ethane recovery). 1.5 Explain NGL recovery with cryogenic processing (high ethane recovery) 1.6 Explain Sulfur recovery and tail gas cleanup. • High sulfur recovery rates. • Low sulfur recovery rates. 1.7 Explain NGL extraction plant costs for larger facilities.	• Explain the basic premises for all plant component cost data. • Explain Amine Treating. • Explain glycol dehydration. • Explain NGL recovery with straight refrigeration • Explain Sulfur recovery and tail gas cleanup.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals	-	-	Explain NGL recovery with straight refrigeration

General objectives 2.0: Describe Natural Gas Processing Plants						
4-7	2.1 Describe Plant with sweet gas feed and 98% ethane recovery. • Overview of plant feed and product slate. • Compression. • heat exchange • dehydration • propane refrigeration • hydrocarbon recovery • amine treating • deethanizer • residue compression 2.2 Explain Plant with sour gas feed, NGL, and sulfur recovery. • Overview of plant feed and product slate. • gas treating • sulfur recovery • dehydration • hydrocarbon recovery • liquids processing 2.3 Describe plant with sour gas feed NGL recovery, and nitrogen rejection. • Overview of plant feed and product slate. • gas treating • sulfur recovery • dehydration • Nitrogen Rejection Unit	• Explain Plant with sweet gas feed and ethane recovery. • Describe Plant with sour gas feed, NGL, and sulfur recovery. • Explain plant with sour gas feed NGL recovery, and nitrogen rejection.	Whiteboard, Computer related software, PowerPoint projectors, recommende d text books, flip charts, lecture notes, and related journals	-	-	Explain Plant with sweet gas feed and ethane recovery. Explain Plant with sour gas feed, NGL, and sulfur recovery. Describe plant with sour gas feed NGL recovery, and nitrogen rejection

	(NRU) and cold box • Liquid processing.					
General Objectives 3.0 Appreciate natural gas liquefaction Process						
8-10	3.1 Describe liquefaction processes. 3.2 Describe refrigeration systems. 3.3 Describe products of liquefaction: • Liquefied petroleum gas (LPG) • Natural gas liquids (NGL) • Liquefied natural gas (LNG) production. 3.4.Describe storage facilities for LNG. 3.5. Describe shipping facilities for LNG. 3.6.Explain the Gas to liquids (GTL) process. 3.7.Explain the Gas to Power process.	• Explain the liquefaction of Natural gas. • Explain the natural gas liquid recovery processes. • Describe the facilities utilized in LNG storage. • Explain the shipping of LNG.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	Describe liquefaction processes. Describe products of liquefaction Describe shipping and storage facilities for LNG Describe GTL and Gas to power processes.
General objective 4.0: Understand Liquefied Natural Gas Processing						
11-13	4.1 Understand peak shaving plants and satellite facilities.	• Explain peak shaving plants and satellite facilities.	Whiteboard, Computer related	-	-	Explainpeak shaving plants and satellite

	4.2 Describe gas treating before liquefaction. 4.5. Describe the various types of LNG technologies.	• Explain gas treating before liquefaction.	software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.			facilities.
General Objectives 5.0:Apply design concepts in industrial processing of natural gas						
	6.1 Apply design concepts to the following processes: • Liquefied natural gas process • Gas to liquid process • Compressed natural gas process • Liquid petroleum gas process • Gas to methanol process • Gas to power process • Gas to fertilizer process. 6.2 Use specific process flow diagram (PFD) to describe the selected process. 6.3 Use the PFD in 6.2 above to carry out process calculation	• Explain various manufacturing technologies. • Explain each unit using a particular process flow diagram. Explain both chemical and physical conversion in each. • Select basis and some operating parameters for the process. • Estimate the material and energy balances. • Determine the size and the capacity of the major process equipment. • Calculate the duty of the major equipment	Recommended text, Marker and whiteboard PC and projector. Chemical processing simulation software etc.	-	-	Find the minimum of operating parameters of a selected unit using ASPEN HYSYS and any other related package

	6.4 Carry out process integration 6.5 Carry out cost estimates 6.6 Describe environmental concern 6.7 Explain application of the process selected	• Develop an optimized Process Flow Diagram (PFD). • Indicate all utilities in the PFD. Show major control loops and instrument. • Simulate the process using any recommended simulation software • Estimate the cost of operation • Identify waste generated and possible environmental pollution. • List and explain and the uses of each products					
Objectives 6.0: Comprehend the transportation and storage of natural gas							
8-10	6.1 Explain the transportation of natural gas. 6.2 Describe market centers 6.3 Explain the storage process of gas. • Storage facilities. 6.4 Describe the transportation of natural gas liquids. a. Ethane-Propane Mixtures	• Explain the transportation of natural gas. • Explain market centers. • Explain transportation of natural gas liquids.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts,	-	-	Describe the storage of natural gas liquids	

	b. Liquefied Petroleum Gas c. Butanes d. Natural Gasoline 6.5 Describe the storage of natural gas liquids.		lecture notes, and related journals.			

Course Title: Gas transmission and distribution networks	**Code: GPT 422**	**Credit Hour: 2** **Credit Unit:2**
	Pre-requisite:	**Theoretical: 2 hours/week**
Year: 2 Semester: 2		**Practical : 0 hours/week**

Goal: This course is designed to provide students with knowledge and skills in gas transmission and distribution networks

General Objectives: On completion of the course, the student should be able to:
1.0 Outline methods of transportation of natural gas
2.0 Comprehend transmission of natural gas pipeline.
3.0 Identify some problems associated with natural gas transmission.
4.0 Apply computer application in natural gas transmission.
5.0 Identify essential features of LNG ships and storage tanks.
6.0 Identify equipment required for gas transmission.
7.0 Compute conditions for gas distribution.

Programme: (Higher National Diploma) in Petroleum and Gas Processing Engineering (Petrochemical and Gas Processing Option).						
Course Title: Gas transmission and distribution networks				**Code: GPT 422**	**CH: 2**	**CU:2**
Goal: This course is designed to provide students with knowledge in gas transmission and distribution networks						
Theoretical Content				**Practical Content**		
General Objective 1.0: Outline the methods of transportation of natural gas						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1-2	1.1 Describe transportation by pipeline. 1.2 State the advantages and limitations of transportation by pipeline. 1.3 Explain why pipelines	• Give an overview of natural gas transportation by pipeline. • Describe the techniques used in protecting pipelines. • Explain the transportation of gas via ships.	Whiteboard, Computer related software, PowerPoint projectors, recommended	-	-	Explain why pipelines are buried.

	are buried. 1.4 Enumerate methods of protection of pipeline against corrosion. 1.5 Describe transportation by ships (LNG ships). 1.6 Compare the two methods of transportation.	• Assess the methods of gas transportation.	text books, flip charts, lecture notes, and related journals.			
General Objective: 2.0: transportation of natural gas by pipeline						
3-4	2.1 State the factors which determine transportation or transmission by pipeline. 2.2 Explain pipeline design and construction in terms of: a. Weymouth equation b. Pan Handle A equation. c. Pan Handle B equation. d. Clindinst equation. e. Pipeline	• Explain the design consideration of gas pipelines. • Explain gas compression stations. • Explain pipeline operations. • Explain the flow equations of gas. • Explain safety considerations in laying pipelines.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	Describe route selection and laying of pipeline according to types.

	operation flow models. 2.3 Describe route selection and laying of pipeline according to types. 2.4 Explain safety and security of pipelines.					
General Objective: 3.0 : Identify some problems associated with gas transmission by pipeline						
5-6	3.1 Enumerate associated problems viz: a. Systems rotating machines maintenance practice. b. Presence of hydrates. c. Corrosion d. Safety practices and engineering. e. Inexperienced personnel. f. Human resources development. g. Management.	Explain the problems associated with natural gas transmission.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, Lecture notes, and related journals.	-	-	State the problems associated with natural gas transmission

General Objectives 4.0: Apply computer application in natural gas transmission						
4	4.1 Review computer and computation. 4.2 Explain computer record keeping and retrieval. 4.3 Explain vital parameters usually recorded by computer in gas transmission. 4.4 Explain the monitoring of operations. 4.5 Explain other computer aided design (CAD). 4.6 Explain the use of computer in planning, formulation of policies, etc.	• Explain the key gas parameters recorded by a computer during transmission. • Explain the significance of computers in gas planning, formulation etc.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	Explain the use of computer in planning, formulation of policies.

General Objectives 5.0: Identify essential features of LNG Ships and storage Tanks						
7-8	5.1 Describe the construction features for provision and maintenance of low temp-cryogenics. 5.2 State materials of construction of LNG ships and storage tanks. 5.3 Describe the special operating equipment for LNG operations. 5.4 Explain safety and security measures of	• Explain the storage facilities of natural gas. • Explain the process of LNG regasification. • Explain safety considerations used in LNG ships.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals	-	-	Describe the special operating equipment for LNG operations

	LNG ships. 5.5 Describe the regasification of LNG to supply consumers.					
General Objectives 6.0 Identify equipment required for gas transmission						
9-10	6.1 Enumerate the equipment for gas transmission e.g. a. Compressors. b. Electrical/electronic equipment. c. Valves, etc. d. Gas meter etc. 6.2 Explain gas flow meter in calculations using Orifice model.	• Describe the equipment used for gas transmission. • Explain gas metering.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	Explain gas flow meter in calculations using Orifice model.
General Objectives 7.0: Compute conditions for gas distribution						
11-12	7.1 Distinguish between gas distribution to industry and private homes. 7.2 Estimate the volume of gas to be supplied in order to recover the investment on pipeline. 7.3 Explain the need for public awareness	• Explain the significance of enlightening the public on gas utilization. • Explain the maximization of profitability from gas in a pipeline.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related	-	-	Explain the need for public awareness about the use of gas

	about the use of gas.		journals.			

PROGRAMME: HIGHER NATIONAL DIPLOMA (HND) IN PETROLEUM AND GAS PROCESSING ENGINEERING (GAS PROCESSING OPTION)		
COURSE TITLE: PIPELINE ENGINEERING	**Code:** GPT 423	**CH: 2 CU: 2**
	Pre-requisite:	**Theoretical: 2 Hours/week**
Year: 2 Semester: 2		**Practical: 2 Hours/week**

Goal: This course is designed to acquaint students with the fundamental principles and applications of pipeline engineering, materials

General Objectives: On completion of the course, the student should be able to:

Appreciate gas pipeline system

1.0 Comprehend the fundamental aspects of gas flow
2.0 Comprehend pipeline design, installation and construction
3.0 Appreciate pipeline hydraulic analysis, mechanical design and materials selection
4.0 Comprehend material selection and corrosion control
5.0 Appreciate defect assessment on pipelines
6.0 Appreciate pipeline integrity: maintenance, inspection and risk assessment

PROGRAMME: HIGHER NATIONAL DIPLOMA (HND) PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (GAS PROCESSING OPTION)			
COURSE TITLE: Pipeline Engineering	**Code:** GPT 423	**CH: 2**	**CU: 2**
Goal: This course is designed to acquaint the student with the fundamental principles and applications of pipeline engineering, materials			
Theoretical Content	**Practical Content**		

General Objective: 1.0 Appreciate Gas Pipeline Engineering System

Week	Specific Learning Outcomes	Teacher's Activities	Resources	Specific Learning Outcomes	Teacher's Activities	Evaluation
1-2	1.1 Explain gas pipeline engineering system 1.2 State some Basic pipeline terms 1.3 Explain factors influencing Pipeline Design 1.4 Explain stages of a pipeline project 1.5 Describe various description and general requirements of standards, codes and regulations 1.6 Explain principles of pipeline design, construction and installation 1.7 Calculate wall thickness based on different design codes or standards	• Discuss Pipeline engineering system. • Define pipeline terms • State factors affecting pipeline design and route selection • State pipeline standards and • Discus principle of pipeline design • Assess the students.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, and related journals.	-	-	Define pipeline engineering. List factors affecting pipeline design. Explain general requirements of standards, codes and regulations procedures Evaluate wall thickness on different design codes.
General Objective: 2.0 Comprehend the fundamental aspects of gas flow						
3-4	2.1 Calculate gas densities. 2.2 State continuity equation for gas flow 2.3 State the Reynolds number and friction factor for gas flow.	• Evaluate gas densities for compressible flow • Solve examples with continuity	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip	Determine Reynolds numbers, friction factors and pressure drops	Guide students to demonstrate how Reynolds equipment operates. The student should follow the	Evaluate mass flow rate of the gas. Calculate density, volume flow rate and velocity of the gas at pipeline inlet

	2.4 State the Gas flow equations. 2.5 Explain gas compressors, 2.6 State types of gas compressors 2.7 Select types of gas compressors & drivers. 2.8 Explain the Isothermal and adiabatic gas compression processes. 2.9 Calculate work (power) required for gas compression. 2.10 Determine gas compression equations. 2.11 State guidelines for compressor design. 2.12 State design optimization of gas pipelines	equation for gas flow. • Discuss gas compressors and its working principles. • Calculate power required for gas compression. • State design equation for designing of optimization of gas pipeline. • Assess the students.	charts, lecture notes, and related journals and Practical manuals	Determine the head loss associated with flow Determine flow meter Characteristics	instructions given in the manual and conduct the experiment. They should also prepare a report on the practical conducted	and outlet Explain gas compressors and its working principles. Calculate power required for gas compression

General Objectives: 3.0 Comprehend pipeline design, installation and construction						
5-8	3.1 Explain different approaches of pipeline design for offshore and onshore 3.2 Describe different pipeline configurations, including pipe-in-pipe bundles 3.3 Explain the hydrodynamics around offshore pipelines	• Describe Pipeline design for offshore and onshore. • Describe hydrodynamics around the offshore. • Describe	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, e-books	-	-	Explain pipeline configuration Explain the hydrodynamics around offshore. State criteria for designing of pipelines

	3.4 Explain stress assessment of pipelines 3.5 Explain hydro-testing, and Commissioning operations 3.6 Explain procurement, and Quality assurance 3.7 State methods of onshore and offshore pipeline installation	procurement and quality assurance in pipeline. • Explain pipeline installation methods. • Explain the commissioning of the operations	related journals.			State methods of pipeline installation.
General Objective: 4.0Appreciate pipeline hydraulic analysis, mechanical design and materials selection						
9-10	4.1 Explain the thermodynamic principles and flow properties of the different fluid transported by pipelines 4.2 Evaluate the basic flow calculations for gases, liquids and multiphase pipelines 4.3 State the problems caused by changes in flow condition during the pipeline's operations (e.g wax and hydrate formation, etc) 4.4 State the mechanical design parameters, criteria for mechanical design	• Describe thermodynamics flow properties of fluid transported via pipeline. • Calculate flow for fluid through multiphase pipeline. • List criteria for mechanical design. • Solve numerical	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, e-books related journals.	Determine Maximum Test Pressure and Test Section Volume for Hydraulic Testing of Pipelines	The student should follow the instructions given in the manual and conduct the experiment. They should also prepare a report on the practical conducted	State thermodynamics properties of fluid flow. Evaluate flow for fluid through multiphase pipeline. State criteria for design Solve examples with design equation of maximum allowable pressure (MAP)

	including codes. 4.5 State the Specified Minimum Yield Strength (SMYS) of pipeline materials. 4.6 State the calculation of Maximum Allowable Pressure (MAP) and minimum required wall thickness for pipelines. 4.7 List design factors and temperature de-rating factors. 4.8 Describe mechanical design for sustained loads.	problem on SMYS • Solve examples with design equation of maximum allowable pressure. .				State design factors and temperature de-rating factors.
General Objectives: 5.0 Comprehend material selection and corrosion control						
11-12	5.1 Explain the material science including the properties of steel and other materials used for pipeline fabrication. 5.2Describe the process of pipeline material selection, including code/standard requirements 5.3 Explain the manufacturing process, including welding standards procedures and non-destructive testing (NDT) techniques for qualifications 5.4Describe corrosion of metals use for pipeline	• Explain properties of material. • Explain materials selection process for pipeline • Explain welding standard procedures • Explain type of corrosion • Explain	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, e-books & related journals.	Determine the effect of internal stress on the corrosion rate of steel. Determine the effect of pH on the rate of corrosion of steel.	Demonstrate how corrosion equipment operates. The student should follow the instructions given in the manual and conduct the experiment. They should also prepare a report on the practical conducted	State the properties of materials for pipeline fabrication. State the process of material selection. Define corrosion. State type of corrosion. Enumerate ways of measuring corrosion in pipelines.

	construction 5.5 State types of corrosion 5.6 Explain method of preventing or mitigate corrosion in pipelines 5.7Describe ways of measuring corrosion in pipelines	corrosion in pipeline and ways of measuring it. • Assess the students.				

General Objective: 6.0 Appreciate defect Assessment on Pipelines						
13-14	6.1 Explain the types of defects on pipelines, including failure statistics and the relative causes of pipeline failures. 6.2 Explain failure modes and describe how pipelines fail 6.3 Identify defect assessment, including the different codes and standards used to carry out fit-for-purpose assessments of defects and damage 6.4 list design code and standard requirements 6.5 State pipeline engineering critical assessment (ECA)	• State types of. defect in pipeline • List causes of pipeline failure • State codes and standard for defect assessment. pipeline standards and • List engineering critical assessment	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, related journals & e-books	Determine the cause and failure of defect in pipeline	The student should follow the instructions given in the manual and conduct the experiment. They should also prepare a report on the practical conducted	State types of defects on pipeline. Identify defect assessment. State engineering critical assessment of pipeline.

General Objective 7.0: Appreciate pipeline integrity, maintenance, inspection and risk assessment						
15	7.1Explain Pipeline anomalies and defects 7.2Describe the principles and applications of the in-line inspection techniques and existing tools 7.3Explain the Survey methods for onshore and offshore pipelines	• Explain anomalies and defects of pipeline. • Explain application of the in-line inspection techniques. • List survey methods for onshore and offshore pipelines.	Whiteboard, Computer related software, PowerPoint projectors, recommended text books, flip charts, lecture notes, related journals & e-books	-	-	Explain anomalies and defects of pipeline. State in-line inspection techniques

PROGRAMME: HIGHER NATIONAL DIPLOMA HND PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (PETROCHEMICAL AND POLYMER OPTION)		
Course Title: Advanced Petrochemical Process Technology III	**Course Code: PPT 421**	**Credit Hour: 2** **Credit Unit: 2**
	Pre-requisite:	**Theoretical: 2 Hours/week**
Year: 2 Semester: 2		**Practical: 0 Hours/week**

Goal: This course is designed to provide students with the knowledge required in production of petrochemicals derived from basic components of crude oil.

General Objectives:

On completion of this course, the students should be able to:

1.0 Comprehend the chemistry and technology for Chlorine/Caustic soda production

2.0 Comprehend the chemistry and technology for sulfuric acid production

3.0 Identify Alkanes (Paraffins), Cyclo-alkanes (Naphthenes), and Aromatics that are important in petrochemicals production

4.0 Comprehend the chemistry and technology for production of Alkanes (Paraffins) and their derivatives

5.0 Comprehend the chemistry and technology for production of Cyclo-alkanes (Naphthenes) and their derivatives

6.0 Comprehend the chemistry and technology for production of Aromatics (Benzene, Toluene, Xylene, and Ethyl benzene) and their derivatives

7.0 Comprehend the chemistry and technology for production of low-tonnage specialty petrochemicals

8.0 Identify the major applications of petrochemicals and their end products

PROGRAMME: HIGHER NATIONAL DIPLOMA HND PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (PETROCHEMICAL AND POLYMER OPTION)						
COURSE TITLE: ADVANCED PETROCHEMICAL PROCESS TECHNOLOGY III			**Course Code: PPT 421**		**CH: 2**	**CU: 2**
Theoretical Content			**Practical Content**			
General Objective: 1.0 Comprehend the chemistry and technology for Chlorine/Caustic soda production						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1	1.1 Sate the importance of Chlorine/Caustic soda in petrochemical industry 1.2 Describe industrial methods for production of chlorine 1.3 Describe industrial methods for production of caustic soda 1.4 List the industrial applications of Chlorine/Caustic soda	Explain the chemistry and technology for production of chlorine and caustic soda	Textbooks, journals, internet materials.	-	-	Describe the chemistry and technology for production of chlorine and caustic soda
General Objectives: 2.0 Comprehend the chemistry and technology for sulfuric acid production						
2-3	2.1 Describe industrial methods for production of sulfuric acid 2.2 Identify petrochemical processes involving sulfuric acid 2.3 Explain Sulfonic acids and their derivatives 2.4 Identify organic sulfates and	Explain the chemistry and technology for production of sulfuric acid and its important derivatives	Textbooks, journals, internet materials.	-	-	With the aid of chemical equations, describe the industrial process for production of sulfuric acid

	their uses					
General Objectives: 3.0 Identify Alkanes (Paraffins), Cyclo-alkanes (Naphthenes), and Aromatics that are important in petrochemicals production						
3-4	3.1 List Alkanes that are important in petrochemicals production 3.2 List Cyclo-alkanes that are important in petrochemicals production 3.3 List Aromatics that are important in petrochemicals production	List and explain Alkanes, Cyclo-alkanes and aromatics that are important in petrochemicals production.	Textbooks, journals, internet materials.	-	-	List Alkanes, Cyclo-alkanes and aromatics that are important in petrochemicals production
General Objectives: 4.0 Comprehend the chemistry and technology for production of Alkanes (Paraffins) and their derivatives						
5-6	4.1 Describe the chemistry of conversion of Alkanes to their derivatives 4.2 Describe the technology for the production of Alkanes and their derivatives 4.3 Identify the applications of Alkanes and their derivatives	Explain the chemistry and technology for the conversion of Alkanes to their derivatives	Textbooks, journals, internet materials.	-	-	Describe the chemistry and technology for the conversion of Alkanes to their derivatives
General Objectives: 5.0 Comprehend the chemistry and technology for production of Cyclo-alkanes (Naphthenes) and their derivatives						
7-8	5.1 Describe the chemistry of conversion of Cyclo-alkanes to their derivatives 5.2 Describe the technology for the production of Cyclo-alkanes and their derivatives 5.3 Identify the applications of Cyclo-alkanes and their	Explain the chemistry and technology for the conversion of Cyclo-alkanes to their derivatives	Textbooks, journals, internet materials.	-	-	Describe the chemistry and technology for the conversion of Cyclo-alkanes to their derivatives

	derivatives					
General Objectives: 6.0 Comprehend the chemistry and technology for production of Aromatics (Benzene, Toluene, Xylene, and Ethyl benzene) and their derivatives						
9-10	6.1 Explain the sources and chemistry of production of aromatics and their derivatives 6.2 Describe the technology for the production of production of aromatics and their derivatives 6.3 State the major applications of aromatics and their derivatives	Explain the chemistry and technology for the conversion of aromatics to their derivatives	Textbooks, journals, internet materials.	-	-	Describe the chemistry and technology for the conversion of aromatics to their derivatives
General Objectives: 7.0 Comprehend the chemistry and technology for production of low-tonnage specialty petrochemicals						
11-13	7.1 Identify the important petrochemicals used as initiators in polymerization 7.2 Identify the important petrochemicals used as plasticizers in polymers 7.3 Identify the important petrochemicals used as solvents in petroleum processing 7.4 Describe the Chemistry and Technology for the production of chemicals in 7.1 – 7.3	Explain the chemistry and technology for the production of low-tonnage specialty petrochemicals	Textbooks, journals, internet materials.	-	-	List the low-tonnage specialty petrochemicals and their major applications

General Objectives: 8.0 Identify the major applications of petrochemicals and their end products						
14-15	8.1 Explain the properties and environmental issues associated with products obtained from Paraffins 8.2 Explain the properties and environmental issues associated with products obtained from Naphthenes 8.3 Explain the properties and environmental issues associated with products obtained from Aromatics (BTX and Ethylbenzene)	Explain the major applications of petrochemicals/end products and their impact on the environment	Textbooks, journals, internet materials.	-	-	State the major applications of petrochemicals/end products and their impact on the environment

PROGRAMME: HIGHER NATIONAL DIPLOMA IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (PETROCHEMICAL AND POLYMER OPTION)		
Course Title: Plastic Processing Technology	**Code: PPT 422**	**CH: 2 CU: 2**
	Pre-requisite:	**Theoretical: 2 Hours/week**
Year: 2 Semester: 1		**Practical: 2 Hours/week**

Goal: This course is designed to provide students with the knowledge and skills of manufacturing of household and engineering plastics using plastic processing machines**.**

General Objectives: On completion of this course, the student should be able to:

1.0 Comprehend thermal and rheological properties of polymers
2.0 Comprehend Injection Molding Process
3.0 Appreciate Extrusion molding and Calendaring
4.0 Comprehend Blow Molding Process
5.0 Appreciate Compression and Transfer Molding Process
6.0 Comprehend Rotational Molding Process
7.0 Comprehend Casting Processing of Composite Materials
8.0 Appreciate Structural Foam Molding

PROGRAMME: HIGHER NATIONAL DIPLOMA IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (PETROCHEMICAL & POLYMER OPTION)						
COURSE TITLE: Plastic Processing Technology				**Code: PPT 422**	**CH:2 CU:2 Theoretical: 2 Hours/week Practical: 0 Hours/week**	
Goal: This course is designed to provide students with the knowledge and skills of manufacturing of household and engineering plastics using plastic processing machines.						
Theoretical Content				**Practical Content**		
General Objective: 1.0 Comprehend the uses of Fertilizers in crop production						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1	1.1 Explain Polymer properties 1.2 Explain thermal behavior of polymer melts 1.3 Explain rheological behavior of polymer melts 1.4 Describe melt flow properties of thermoplastics 1.5 Describe thermal properties of thermo-sets 1.6 Describe thermal/rheological properties of elastomers/rubbers Explain the effect of degradation on thermal	Review thermal/ rheological behavior of polymer melts Explain the activities in 1.4 to 1.5 Explain the degradation of polymer	White Boards, Computers, Related Software, Projector, Interactive Boards, Recommended textbooks, lecture notes & Related Journals	Identify different types of polymers	Guide students to identify polymers	Contrast thermal and rheological properties of polymers. Explain the effect of degradation on thermal properties of polymers

	properties of polymers					
General Objectives 2.0: Comprehend Injection Molding Process						
2-3	2.1 Describe Injection molding machine 2.2 Classify injection molding Machines 2.3 Describe Injection molding process 2.4 Explain the operation of injection molding machine 2.5 Describe injection molding machine Start-up and shut down procedure 2.6 Explain heating, cooling, clamping and ejection systems 2.7 Identify Microprocessor controlled Injection Molding Machines Explain types of Injection molding molds	Explain injection molding processes in activities 2.1 to 2.3 Explain the Operation of injection molding machine activities in 2.4 to 2.5	White Boards, Computers, Related Software, Projector, Interactive Boards, Recommended textbooks, lecture notes, e-books & Related Journals	Students should be able to comprehend the Start-up and shut down procedures Describe Injection molding processes	Demonstrate Start-up and shut down procedure Explain Injection molding processes	Explain injection molding process Describe injection molding machine Start-up and shut down procedure
General Objectives 3.0: Appreciate Extrusion molding and Calendaring						
4-5	3.1 Describe extrusion molding machine 3.2 Describe extrusion molding process 3.3 Explain single screw and twin screw extruders 3.4 Identify types of screws - L/D ratio,	Describe extrusion molding machine Describe calendaring molding machine	White Boards, Computers, Related Software, Projector, Interactive Boards, Recommended textbooks, lecture notes, e-books &	Explain extrusion molding	Identification and Description of extrusion molding machine	Draw/describe extrusion molding machine

	compression ratio 3.5 Explain back pressure, heating, and cooling systems 3.6 Describe calendaring process 3.7 Identify types of extrusion dies 3.8 Describe Drying and mixing equipment in extrusion/calendaring processes 3.9 Describe plastic processing factory waste management		Related Journals Extrusion molding machine			
General Objective 4.0: Describe blow molding process						
6-7	4.1 Explain the basic principles of blow molding 4.2 Identify Material requirements and specifications of blow molding processes 4.3 Describe types of Blow Molding machines 4.4 Describe blow molding cycle Explain blow molding process heating, cooling, and control systems	Describe the blow Molding machine	White Boards, Computers, Related Software, Projectors, Interactive Boards, Recommended textbooks, lecture notes, e-books & Related Journals	Summarize the functions of heating, cooling, and control systems of the blow molding processes	Guide students to demonstrate the functions of heating, cooling, and control system of blow molding process	Describe blow molding process
General Objective: 5.0 Appreciate Compression and Transfer Molding Process						

8-10	5.1 Explain compression molding machine 5.2 Explain compression molding process 5.3 Describe transfer molding process 5.4 Distinguish between compression molding and transfer molding	Explain compression molding machine Explain compression molding process	White Boards, Computers, Related Software, Projectors, Interactive Boards, Recommended textbooks, lecture notes, e-books & Related Journals			Distinguish between compression molding and transfer molding
General Objective: 6.0 Describe Rotational Molding Process						
11-12	6.1 Describe rotational molding machine 6.2 Describe rotational molding process 6.3 Explain the advantages of rotational processes 6.4 Give examples of the applications of rotational molding processes	Explain rotational molding processes	White Boards, Computers, Related Software, Projectors, Interactive Boards, Recommended textbooks, lecture notes, e-books & Related Journals rotational molding machine	Describe rotational molding	Demonstrate rotational molding	Describe rotational molding process
General Objective 7.0: Comprehend Casting Process of Composite Materials						
13-14	7.1 Explain composite materials 7.2 Describe the	Describe composite materials	White Board, Computer, Related Software, Projector,	Describe the casting process of composite materials	Guide students to demonstrate the casting	Describe the casting process of

	casting process of composite materials	Explain the classification of composite materials	recommended textbooks, lecture notes &related Journals		process of composite materials	composite materials

PROGRAMME: HIGHER NATIONAL DIPLOMA HND PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (REFINING OPTION)		
COURSE TITLE: PETROLEUM REFINING PROCESSES III	**Code: PRT 421**	**Contact Hour: 2** **Credit Unit: 2**
	Pre-requisite:	**Theoretical: 2 Hours/week**
Year:2 Semester:2		**Practical: 0 Hours**

Goal: This course is designed to enable students understand the principles of secondary crude oil processing and finishing processes.

General Objectives:

On completion of this course, the student should be able to: -

1.0 Appreciate catalytic cracking processes.

2.0 Comprehend MEROX process.

3.0 Appreciate refinery gases treatment processes.

4.0 Appreciate sulphur recovery processes.

5.0 Comprehend refinery effluent treatment and disposal techniques.

6.0 Appreciate full case-study of a refinery.

7.0 Appreciate recent developments in crude oil refining technologies.

PROGRAMME: HIGHER NATIONAL DIPLOMA HND PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY (REFINING OPTION)

COURSE TITLE: PETROLEUM REFINING PROCESSES III			Code: PRT 421		CH: 2 CU: 2 Theoretical: 2 Hours/week Practical: 0 Hours/week	
Theoretical Content				**Practical Content**		
General Objective 1.0:Appreciate catalytic cracking process						
Week	**Specific Learning Outcomes**	**Teacher's Activities**	**Resources**	**Specific Learning Outcomes**	**Teacher's Activities**	**Evaluation**
1-4	1.1 Define thermal and catalytic cracking. 1.2 Explain catalytic cracking reactions. 1.3 List the types of catalytic reactors. 1.4 Explain effect of catalyst poisoning on its activity. 1.5 Describe factors affecting catalytic cracking process. 1.6 Describe a typical modern Fluid Catalytic Cracking Unit (FCCU). 1.7 Carryout overall material and energy balance of an FCCU. 1.8 Describe the FCCU product purification techniques. 1.9 Describe uses of FCCU products. 1.10 Describe catalysts used in catalytic cracking.	Describe with suitable example the cracking of paraffins, naphthenes and aromatics. Describe catalysts used in catalytic cracking.	Whiteboard, Marker, Textbooks, Lecture notes, Journals, etc.	-	-	Define thermal and catalytic cracking. Explain the cracking reactions of paraffins. Explain the cracking reactions of Naphthenes and aromatics.
General Objective 2.0: Apprehend MEROX process						
5 – 6	2.1 Define MEROX. 2.2 Explain the importance of MEROX	Draw PFD of MEROX extraction process.	Whiteboard,			Define MEROX process.

	process. 2.3 Describe the MEROX reactions. 2.4 Describe MEROX extraction. 2.5 Describe MEROX sweetening. 2.6 Carryout material and energy balance on MEROX unit	Draw a PFD of MEROX sweetening process. Carryout material and energy balance on a typical MEROX unit.	Textbooks, Lecture notes, journals, etc.			Explain MEROX reactions. Distinguish between MEROX sweetening and MEROX extraction.
GENERAL OBJECTIVES 3.0: Appreciate refinery gases treatment processes						
7-8	3.1 Define refinery gases 3.2 Describe sources of refinery gases. 3.3 Describe the importance of refinery gases. 3.4 Describe the importance of refinery gas treatment. 3.5 Describe gas processing unit. 3.6 Carryout material and energy balance on gas treating unit.	Describe a typical gas processing unit. Describe solvents used in acid gas removal from refinery gases.	Whiteboard, Marker, Textbooks, journals, etc.	-	-	State the components of refinery gases. State the importance of refinery gases. Mention impurities found in refinery gases. State the solvents used for acid gas removal from refinery gases.

General Objective 4.0: Appreciate sulphur recovery processes.						
9 - 10	4.1 State the objectives of Sulphur recovery. 4.2 Enumerate Sulphur recovery processes. 4.3 Describe the Claus process. 4.4 Describe the Direct Oxidation process. 4.5 Describe Stretford process. 4.6 Carryout material and energy balance of a typical sulphur recovery process.	List Sulphur Recovery Processes. Write the chemical equations for Sulphur recovery processes.	Whiteboard, Markers, Textbooks, Lecture notes, Journals, etc.	-	-	State the objectives of sulphur recovery. List sulphur recovery processes.
General Objective 5.0: Appreciate full case-study of a refinery						
11 - 12	5.1 Analyze preliminary and full crude oil assay. 5.2 Analyze the yield and quality of ADU and VDU products. 5.3 Analyze the yield and quality of products from the reforming, cracking and alkylation units. 5.4 Analyze the yield and quality of products from lubes processing unit. 5.5 Carryout Comparative analysis of crude oil assay with actual yields from the refinery units. 5.6 Carryout Comparative analysis of crude oil assay quality results with actual from the refinery units.	Describe how to analyze the yield and quality of products from the reforming, cracking, alkylation and other units.	Whiteboard, Markers, Textbooks, Lecture notes, Crude oil assay data, Journals, etc.	-	-	Outline the steps involved in the preparation of crude oil preliminary and full assay List the quality parameters of products from ADU and VDU.
General Objective 6.0: Appreciate recent developments in oil refining technologies						

13 - 14	6.1 Describe refinery process and products evolution 6.2 Explain new technological developments in ADU and VDU. 6.3 Describe strategies involved in Sulphur from gasoline 6.4 Explain ultra-low sulphur diesel production. 6.5 Explain hydrocracking 6.6 Describe development in hydrocracking processes 6.7 Describe sources of hydrogen and its utilization in a typical refinery.	Describe refinery process and products evolution	Whiteboard, Markers, Textbooks, Lecture notes, Journals, etc.	-	-	State the recent developments in oil refining processes Explain how low sulphur gasoline can be achieved Explain a broad vision of future of oil refining industry from technical, safety and environmental constraints
General Objective 7.0: Apprehend refinery effluent treatment and disposal techniques						
15	7.1 Define refinery effluent. 7.2 Describe types of refinery effluents. 7.3 Describe properties of refinery effluents (Biological oxygen demand (BOD), Chemical oxygen demand (COD), Temperature, etc.) 7.4 Describe the effects of refinery effluents on the environment 7.5 Describe the physical, chemical and biological treatment methods of	Describe types of refinery effluents. Explain composition and properties of	Whiteboard, Makers, Textbooks, Lecture notes, Journals and etc.	-	-	Define refinery effluents Define COD And BOD State the effects of refinery effluents on the

	refinery effluents. 7.6 Carryout material and energy balance na a typical wastewater (effluent) treatment plant.	refinery effluents.				environment.

LIST OF PHYSICAL FACILITIES REQUIRED TO MOUNT HIGHER NATIONAL DIPLOMA IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY WITH OPTIONS IN:

I. **PETROCHEMICAL AND GAS PROCESSING ENGINEERING TECHNOLOGY**
II. **PETROCHEMICAL AND POLYMER ENGINEERING TECHNOLOGY**
III. **GAS PROCESSING ENGINEERING TECHNOLOGY**
IV. **PETROLEUM REFINING ENGINEERING TECHNOLOGY**

S/N	LABORATORIES	WORKSHOPS	STUDIOS
1	Fluid/Hydraulic Laboratory	Process Plant Simulator Workshop	Drawing Studio
2	Strength of Materials Laboratory	Unit Operations Workshop	Computer Studio
3	Gas/Petroleum Processing Laboratory	Welding and Fabrication Workshop	
4	Petrochemical Laboratory	Safety Workshop	
5	Instrument Analysis Laboratory	Polymer Workshop	
6	Thermodynamics Laboratory		
7	Polymer Analysis Laboratory		

EQUIPMENT/TOOLS REQUIRED IN THE LABORATORIES, WORKSHOPS AND STUDIOS FOR MOUNTING

HIGHER NATIONAL DIPLOMA IN PETROLEUM AND GAS PROCESSING ENGINEERING TECHNOLOGY OPTIONS IN:

I. **PETROCHEMICAL AND GAS PROCESSING ENGINEERING TECHNOLOGY**
II. **PETROCHEMICAL AND POLYMER ENGINEERING TECHNOLOGY**
III. **GAS PROCESSING ENGINEERING TECHNOLOGY**
IV. **PETROLEUM REFINING ENGINEERING TECHNOLOGY**

(A) LABORATORIES

1) Fluid/Hydraulic Laboratory

S/NO.	DESCRIPTION OF EQUIPMENT	QUANTITY REQUIRED
1.	Laminar Flow Equipment with Accessories	1
2.	Flow through an Orifice with Accessories	1
3.	Pipe Friction with Accessories	1
4.	Free and Forced Vortices with Accessories	1

2) Strength of Materials Laboratory

S/NO.	DESCRIPTION OF EQUIPMENT	QUANTITY REQUIRED
1.	Polygon of Force Apparatus	1
2.	Young’s Modulus Apparatus	1
3.	Shearing Force Apparatus	1

4.	Bending Moments Apparatus	1
5.	Gyroscope Apparatus	1
6.	Centrifugal Force Apparatus	1

3) Gas/Petroleum Processing Laboratory

S/NO.	DESCRIPTION OF EQUIPMENT	QUANTITY REQUIRED
1.	Absolute Viscosity Bath Lovibond colour Comparator	1
2.	Carbon Residue Apparatus	1
3.	Pour Point Apparatus	1
4.	Distillation Apparatus	1
5.	Refractometer	2
6.	Smoke Point Tester	1
7.	Penetrometer	1
8.	Aniline Point Testing Apparatus	1
9.	Kinematic Viscosity Tester	1
10.	ASTM Colour Comparator	1
11.	Constant Temperature Bath	2
12.	Vapour Pressure Apparatus	1

13.	Oven Dryer	1
14.	Weighing Balance (Analytical)	2
15.	Air Compressor	1
16.	Orsat Gas Analyser	2
17.	Bitumen Softening Point Apparatus	1
18.	Melting Point Apparatus	1
19.	Peristaltic Pump	1
20.	Ice Making Machine	1
21.	Distilled Water Making Equipment	1
22.	Centrifuge Machine with Accessories	2
23.	Sulphur Analyzer with Accessories	1
24.	Salts in Crude Analyzer	1
25	Wheel Bearing Grease Tester	1
26	Baths for Oxidation stability of gasoline test	1
27	Freezing point testing apparatus	1
28	Cobalt bromide test apparatus	1

4) Petrochemical Laboratory

S/NO.	DESCRIPTION OF EQUIPMENT	QUANTITY REQUIRED
1.	Oven	2
2.	Titremeter Apparatus	4
3.	Variostat	1
4.	Vacuum Pump	4
5.	Rotary Viscometer with Accessories	1
6.	Rotary Evaporator with Accessories	2
7.	Electronic Weighing Balance	5
8.	Heating Mantle	2
9.	Micro Burettes	100 pieces
10.	Crucible Pots	100
11.	Round Bottom Flasks	50 each
12.	Respiratory Bottles	100
13.	Beakers (Graduated 250, 500, 100ml)	50 each
14.	Tripod Stands	**30**
15.	Bunsen Burner	**20**
16.	Retort Stand	20
17.	Manometer	1
18.	Thermometer	10

19	Pilot Plant Distillation Unit (optional)	1

5) Instrument Analysis Laboratory

S/NO.	DESCRIPTION OF EQUIPMENT	QUANTITY REQUIRED
1.	Spectronic 21	1
2.	Flexible Optic Tintometer	1
3.	HPLC	1
4.	TLC	2
5.	Densitometer	1
6.	Turbidimeter	1
7.	Analytical Balance	2
8.	pH Meter (Digital)	2
9.	Polarimeter	1
10.	Titrimeter	2
11.	Magnetic Stirrer	2
12.	Refractometer	1
13.	Compressor	1
14.	Vacuum Pump	1
Optional Equipment		

15.	Oxygen Electrode	1
16	Auto bomb calorimeter with accessories	1
17	Gas chromatograph	1
18	Flame photometer	1
19	Atomic Absorption Spectrophotometer	1

6) Thermodynamics Laboratory

S/NO.	DESCRIPTION OF EQUIPMENT	QUANTITY REQUIRED
1.	Energy Converter	1
2.	Cp/Cv Apparatus with Accessories	1
3.	Boyle's Law Apparatus	5
4.	Charles's Law Apparatus	5
5.	Heat of Combustion Apparatus	1
6.	Rotary Viscometer with Accessories	1
7.	Stroboscope	1
8.	Tachometer	1
9.	Calorimeter	2
10.	Water Bath with stirrer	2

11.	Orsat Gas Analyzer	1
12.	Stirling Heat Pump	1
13.	Steam Boiler Plant	1
14.	Electronic Anemometer	1
15.	Falling Viscometer	1
16.	Energy Conversion Kit	2

7. Polymer Analysis Laboratory (for HND Petrochemical and Polymer Option only)

S/NO.	DESCRIPTION OF EQUIPMENT	QUANTITY REQUIRED
1.	Impact test apparatus.	1
2.	Micrometer screw gauge.	5
3.	Micrometer (Digital).	5
4.	Hounsfield bench Tensometer	2
5.	Hounsfield Rubber Testing.	1
6.	Instron Bench Tensometer	1
7.	Vernier Calipers (manual)	5
8.	Vernier Calipers (digital)	5
9.	Rubber Curing Chamber	1

10.	Rheometer	2
11.	Abraider	1
12.	Plastimeter	1
13.	Polarimeter	1
14.	Titrimeter Apparatus	1
15	Weighing Balance	1
Optional Equipment		
16.	Atomic Absorption spectrophotometer	1
17	Beckman IR Spectrometer	1
18	Differential Scanning Calorimeter DSC	1

(B) WORKSHOPS

1) Process Plant Simulator Workshop

S/NO.	DESCRIPTION OF EQUIPMENT	QUANTITY REQUIRED
1.	Control Console Unit	1
2.	Plant Module Unit	1
3.	Utilities – Air Compressor, Overhead Water Tank, Water Heater, Boiler	1 each
Optional Equipment		
4	Crude Oil Refinery Simulator	1

5	Offshore Oil and Gas Production Generic Simulator	1
6	Liquefied Natural Gas process plant model	1
7	Heat exchanger model	1
8.	Oxygen Plant	1

2) Unit Operations Workshop

S/NO.	DESCRIPTION OF EQUIPMENT	QUANTITY REQUIRED
1	Liquid-liquid-extraction unit	1
2	Solid-liquid-extraction unit	1
3	Liquid diffusion coefficient apparatus	1
4	Gaseous diffusion coefficient apparatus	1
5	Gas absorption column	1
6	Single-effect climbing film evaporator	1
7	Fractionation column	1
8	Universal pump test rig	1
9	Boiler	1
10	Compressor	1

11	Heat of conduction apparatus	1
12	Sedimentation studies apparatus	1
13.	Corrosion Study Kit	1

(3) Welding and Fabrication Shop

S/N	Description of Equipment	Quantity Required
1.	Universal welding machine	3
2.	Oxygen cylinder	5
3.	Acetylene cylinder	5
4.	Argon cylinders	2
5.	CO_2 cylinders	2
6.	Oxy acetylene welding manifold (regulator)	2
7.	Weld joint teaching aids (diagrams)	2
8.	Apron (leather)	15
9.	Hand gloves	15
10.	Welding head shield	15
11.	Welding booth/cubicle	3
12.	Working benches, for each welding machine	3
13.	Safety charts	Assorted
14.	Safety boots	6
15.	**Fire Extinguisher/sand buckets**	**each**

4) **Safety Workshop**

S/No.	Description of Equipment	Quantity Required
1.	Eye protection spectacles: - general purpose - grade 2 impact	40NO 15no.
2	Eye protection goggles: - grade 2 impact - chemical, type C - dust, type D - gas, type G - molten metal, type M	15no.each
3	Face shields: grade 2 impact, C resistance grade 2 impact, C and M resistance grade 1 impact, C and M resistance Ultraviolet	5 each
4	Eye wash assembly	2
5	Fire extinguishers - BCF dry powder - BCF	3each
6	First aid kit (up to 30 persons)	3
7	Resuscitator (Brook airway)	5
8	Lifting manikin model	1
9	Safety hand gloves:	Assorted

	- sterile types - non-sterile types Heat/cold resistance type	(1strream of 40students)
10	Hazard warning labels: - Chemical (corrosive, flammable, irritant, toxic) - general (laser beam, radiation, radioactive, toxic)	1no symbol each
11	Protective coats: - flame retardant - chemical resistant	(1steam of 40 students)
12	Dust/mist/fumes masks	5 each
13	Respirators: - dust/mist type - mercury vapour type - nuisance odor - organic vapour - acid gas	2pack 3 3 3 2
14	Safety caps (Hard hats)	30
15	Leather aprons	15
16	Fire buckets	5

(5) Polymer Workshop (for HND Petrochemical and Polymer Option only)

S/NO.	DESCRIPTION OF EQUIPMENT	QUANTITY REQUIRED
1	Pipe Extruder (single screw pipe extruder line)	1
2	Film extrusion machine. (small size, single screw film extruder line)	1
3	Injection molding machine (small size clamping force)	1
4	Blow molding machine.	1
5	Compression molding machine.	1
6	Calendaring machine. (small size)	1
7	Tumble blender	1
8	Ball mill.	1
9	Rubber ripple roll mill	1
10	Two-roll mill.	1
11	Internal mixer.	1

(3) STUDIO

1) Computer Studio

S/No.	Description of Equipment	Quantity Required
1.	Computer (PC)	40
2.	Printer	2
3.	Scanner	2
4.	Inverter/battery	Assorted
5.	Software	Assorted

2) Drawing Studio-: Drawing Studio (At least 40Nos Adjustable Drawing Tables and Stools)

NATIONAL BOARD FOR TECHNICAL EDUCATION

Plot B, Bida Road, P. M. B. 2239, Kaduna

List of Participants for
Title- Critique workshop for HND options in Petrochemical and Polymer, Gas processing and Petroleum Refining Engineering Technology.
Date- from 4th April 2022 to 8th April 2022
Venue- NBTE Consult, No 9 Kajuru Road off Degel 1 Ang. Rimi GRA Kaduna.

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