



NATIONAL BOARD FOR TECHNICAL EDUCATION

PLOT B BIDA ROAD, P.M.B. 2239, KADUNA, NIGERIA

**HIGHER NATIONAL DIPLOMA
IN**

**WOOD AND PAPER TECHNOLOGY
(PAPER AND PAPER PRODUCTS TECHNOLOGY)**

CURRICULUM AND COURSE SPECIFICATIONS

JUNE, 2026

PREFACE

The transformation of Nigeria's agricultural sector remains central to the nation's aspirations for sustainable economic growth, food security, job creation, industrial development, and poverty reduction. As agriculture continues to evolve in response to technological advancements, climate change, emerging global market demands, and the need for increased productivity across agricultural value chains, it has become imperative to ensure that curricula in Nigerian tertiary institutions remain relevant, responsive, and aligned with contemporary industry requirements. It is against this backdrop that we embarked on the comprehensive review and modernization of Agricultural curricula for Nigerian tertiary institutions. The review process was designed to address identified skills gaps, integrate emerging technologies and innovations, strengthen entrepreneurship and employability competencies, promote climate-smart agriculture, and align training programmes with the industry expectations and global best practices. The successful execution of this important project was made possible through the invaluable support and commitment of key stakeholders. I wish to express profound appreciation to the Honourable Minister of Education for providing the policy direction and leadership that facilitated this initiative. I also extend sincere gratitude to the Honourable Minister of Agriculture and Food Security and the Honourable Minister of Livestock Development for their unwavering support, technical contributions, and commitment to strengthening agricultural education and workforce development in Nigeria. Special appreciation goes to the Tertiary Education Trust Fund (TETFund) for providing the special intervention grant that enabled the conduct of nationwide skills gap analyses and supported the series of national curriculum review and development workshops. The findings from the skills gap studies provided critical evidence and industry insights that guided the review process and ensured that the curricula reflect current and future workforce requirements within the agricultural sector.

I also acknowledge with gratitude the immense contributions of the Sector Skills Council for Agriculture, whose expertise and industry perspectives greatly enriched the curriculum development process. Equally commendable are the efforts of members of the Implementation Committee, resource persons, industry experts, professional bodies, French Embassy in Nigeria, regulatory agencies, academic institutions, employers, development partners, and other stakeholders who devoted their time, knowledge, and experience to the various workshops and technical sessions. The revised curricula represent a collective national effort to produce graduates equipped with relevant knowledge, practical skills, digital competencies, entrepreneurial capabilities, and professional attitudes required to drive innovation and productivity across Nigeria's agronomy, forestry, fisheries and livestock sectors. It is my expectation that Institutions offering these programmes will faithfully implement the curricula and continue to collaborate with industry to ensure sustained relevance and quality. I commend all stakeholders for their dedication and contributions to this landmark achievement and look forward to the successful implementation of these curricula for the benefit of our dear nation.

Professor Idris M. Bugaje, FNSE
Chairman, Implementation Committee

EXECUTIVE SECRETARY

National Board for Technical Education (NBTE), Kaduna

ACKNOWLEDGEMENT

The National Board for Technical Education (NBTE) expresses its profound appreciation to all individuals and organizations whose invaluable support, expertise, and commitment made the successful review and modernization of the Agricultural Education curricula for Nigerian tertiary institutions possible. Our sincere gratitude goes to the Honourable Minister of Education for providing the policy direction and leadership that made this national initiative possible. We also appreciate the Honourable Minister of Agriculture and Food Security and the Honourable Minister of Livestock Development for their technical guidance, collaboration, and unwavering commitment to strengthening agricultural education and workforce development in Nigeria. The Board is particularly grateful to the Tertiary Education Trust Fund (TETFund) for providing the special intervention grant that funded the nationwide skills gap analyses, stakeholder engagements, curriculum review exercises, validation meetings, and development workshops. The evidence generated through these studies provided a solid foundation for developing curricula that are relevant, industry-driven, and responsive to national and global agricultural priorities.

Special appreciation is extended to the members of the Sector Skills Council for Agriculture, curriculum specialists, resource persons, academic experts, professional bodies, regulatory agencies, employers, industry practitioners, development partners, and representatives of public and private sector organizations who participated actively in the skills gap studies, technical sessions, validation exercises, and curriculum development workshops. Their diverse expertise and practical insights greatly enriched the quality and relevance of the curricula. We further appreciate the support of the French Embassy in Nigeria and other development partners for their collaboration in promoting excellence and innovation in technical and vocational education within the agricultural sector. Finally, NBTE expresses its gratitude to all tertiary institutions, researchers, facilitators, rapporteurs, technical staff, and administrative personnel whose commitment and hard work contributed to the successful completion of this important national assignment. The Board acknowledges that this achievement is the result of a collective effort and remains confident that the effective implementation of these curricula will contribute significantly to producing competent, innovative, and entrepreneurial graduates capable of advancing sustainable agricultural development, food security, and economic prosperity in Nigeria.



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GENERAL INFORMATION

1.0 TITLE OF THE PROGRAMME

The title of the programme is Higher National Diploma (HND) in Wood and Paper Technology (Paper and Paper Products Technology Option).

2.0 PROGRAMME GOAL

This programme is designed to produce competent, innovative, and environmentally responsible technologists equipped with the knowledge, practical skills, and professional attitudes required for sustainable pulp and paper production, paper products manufacturing and recycling, quality control, packaging technology and industrial management in the paper and allied industries.

3.0 OBJECTIVES OF THE PROGRAMME

At the end of the programme, diplomates should be able to:

- i. Apply scientific, engineering, and technological principles in pulp production, papermaking, paper conversion, and paper products manufacturing.
- ii. Operate, monitor, and optimize paper manufacturing processes to achieve efficient production, product quality, and resource utilization.
- iii. Utilize virgin and recycled fibre resources for sustainable pulp and paper production in line with circular economy principles.
- iv. Apply paper chemistry, additives technology, and process control techniques to improve paper and paper product performance.
- v. Conduct quality testing, quality assurance, and process evaluation using relevant standards and laboratory techniques.
- vi. Design, manufacture, and convert paper products and packaging materials to meet industrial and consumer requirements.
- vii. Operate, maintain, and troubleshoot paper production and converting equipment using appropriate technical and safety procedures.
- viii. Apply environmental management, occupational health, and safety practices in paper and paper products industries.
- ix. Utilize digital technologies, automation systems, and Industry 4.0 tools in paper manufacturing and production management.
- x. Conduct research, innovation, and product development activities for continuous improvement in the paper value chain.
- xi. Apply principles of business management, entrepreneurship, and leadership for effective participation in the paper and packaging industries.
- xii. Promote sustainable resource utilization, waste minimization, recycling, and environmental stewardship in paper production systems.
- xiii. Communicate effectively and work collaboratively with professionals and stakeholders across the pulp, paper, packaging, and allied sectors.
- xiv. Pursue lifelong learning, professional development, and advanced studies in paper technology, packaging technology, materials science, and related disciplines.

4.0 ENTRY REQUIREMENTS

The general entry requirements into the Higher National Diploma (HND) in Wood and Paper Technology (Paper and Paper Products Technology Option) are:

- i) Candidates with National Diploma in Wood and Paper Technology and Forestry and Environmental Technology with at least Lower Credit, from accredited Institutions.
- ii) Must have undergone one (1) year post-ND industrial training experience;
- iii) Candidates with a **Pass** at the ND Level with two (2) or more years post-ND cognate work experience may be considered for admission
- iv) Credit passes in five relevant subjects at not more than two sittings including Mathematics, English Language and three other relevant subjects.

5.0 STRUCTURE/DURATION OF THE PROGRAMME

The HND Wood and Paper Technology (Paper and Paper Products Technology Option) is a terminal programme structured to last for two (2) years (four semesters) of classroom work, laboratory, field trip and workshop practices in relevant MDAs or Units.

Each semester shall be for 17 weeks, made up as follows:

- i) 15 contact weeks of teaching (i.e., lectures and practical sessions etc.) and
- ii) 2 weeks for registration, tests, quizzes and examinations.

6.0 CURRICULUM:

The syllabus of the HND Wood and Paper Technology (Paper and Paper Products Technology Option) programme consists of four (4) main components:

- a. General studies/General education courses
- b. Foundation courses
- c. Professional courses
- d. Project work

7.0 STAFFING REQUIREMENTS

7.1 Core Teaching Staff:

A minimum of four (4) Core Lecturers who should be Lecturer II or above staff, with a minimum qualification of HND/B.Sc in Wood and Paper Technology, Paper and Paper Products Technology, Wood Products Processing Technology, Forestry and Environmental Technology or related programmes.

7.2 Headship of the Department:

The Head of Department shall have at least HND or First Degree and a Master's degree in Paper and Paper Products Technology, Wood and Paper Technology, Wood Products Processing Technology, Wood Science, Forestry and Environmental Technology, Wood Science/Wood

Technology or related fields. He or she shall not be below the rank of a Senior Lecturer, must be registered with the relevant professional body and must have a minimum of twelve (12) years' experience in both academia and industry.

7.3 Technical Staff

There should be technical staff:

i) Technologist

A technologist is a highly skilled professional trained at the Higher National Diploma (HND) level. They possess advanced technical and practical knowledge in their field and are capable of supervising operations, managing projects, operating modern equipment, and applying technology to solve practical problems. In the wood and paper industry, technologists support production planning, process supervision, quality control, research and development, and the application of improved manufacturing technologies.

ii) Technician

A technician is a middle-level manpower trained at the National Diploma (ND) level. Technicians are responsible for carrying out technical tasks, operating tools and equipment, and assisting technologists and professionals in practical activities. In the wood and paper industry, they assist in pulp and paper production, machine operation, laboratory testing, equipment maintenance, and data collection.

iii) Laboratory and Workshop Assistants

Laboratory and workshop assistants are support workers who help in daily laboratory and workshop operations under supervision. They perform basic practical activities such as preparing samples and materials, operating simple tools and equipment, cleaning and maintaining workshop tools, and keeping records. They contribute to the smooth running of laboratory and workshop activities and help improve productivity.

7.4 CAREER AND ACADEMIC PROSPECTS

Holders of the HND in Paper and Paper Products Technology are eligible for direct admission into relevant post graduate programmes and can work in public or private establishments or organizations such as:

- Paper industries;
- Sawmilling Industries;
- Quality Control Officer;
- Environmental and Sustainability Officer;
- Security and Minting Company
- Paper Recycling;
- Tertiary Institutions;
- Upstream and Downstream Sector of Paper Industry;
- Non-Governmental Organizations (NGOs);
- Set up their own businesses etc.

8.0 CERTIFICATION

A diplomate of this Programme shall be awarded the Higher National Diploma (HND) in Wood and Paper Technology (Paper and Paper Products Technology Option).

9.0 AWARD OF HIGHER NATIONAL DIPLOMA (HND)

The Higher National Diploma certificate in Wood and Paper Technology (Paper and Paper Products Technology Option) shall be awarded by the authority of the Academic Board of the institution under the following conditions:

- i) Satisfactory performance in all prescribed course work/assignments, tests/quizzes, workshop practice, laboratory work, field trips, etc.;
- ii) Satisfactory performance in all semester examinations;
- iii) Satisfactory completion of written project/seminar papers.

9.1 Conditions for the Award of HND:

Institutions offering accredited programmes will award the Higher National Diploma to candidates who successfully completed the programme after passing the prescribed course-work, examinations, diploma project etc. Courses shall be graded as follows:

MARK 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	0.00

9.2 Classification of Diplomas:

Diploma Certificates shall be awarded based on the following classifications:

CGPA	CLASS OF DIPLOMA
CGPA 3.50 and above	Distinction
CGPA 3.00-3.49	Upper Credit
CGPA 2.50-2.99	Lower Credit

10.0 ACCREDITATION OF PROGRAMME

The HND Wood and Paper Technology (Paper and Paper Products Technology Option) shall be accredited by the NBTE before the diplomates are awarded the certificates. Details about the process of accrediting a programme for the award of HND are available from the Board's website web.nbte.gov.ng or through correspondence to: The Executive Secretary, NBTE, Plot 'B' Bida Road, P.M.B 2239, Kaduna, Nigeria.

11.0 LOGBOOK

A personal logbook for each course is to be kept by the students. It shall contain all the recordings of the day-to-day, weekly and semester practical works/activities from day one to the end of the programme. This is to be checked, marked appropriately and endorsed by all lecturers concerned at the end of every week.

12.0 FINAL YEAR PROJECTS

Final year students are expected to carry out project work, either on individual or group basis (not more than 2 per group). The project topics should as much as possible be related to the programme and serve as useful tools for further Research and /or Development. Projects should be properly supervised, and their reports well presented. The Institution should develop formats for presenting and grading projects. The formats should be adopted as applied to each stakeholder.

13.0 GUIDANCE NOTES FOR TEACHERS OF THE PROGRAMME

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

13.2 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.

13.3 As the success of the credit unit system depends on the articulation of programmes between the institution and industry, the Curriculum content has been written in behavioral objectives, so that the expected performance of the student is clear to all students who successfully completed some of the courses or the diplomates of the programme. There is a slight departure in the presentation of the performance-based curriculum which requires the conditions under which the performance is expected to be carried out and the criteria for the acceptable levels of performance. It is a deliberate attempt to further involve the staff of the department teaching the programme to write their own curriculum stating the conditions existing in their institution under which the performance can take place and follow that with the criteria for determining an acceptable 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.

13.4 The teaching of 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 practice in the ratio of 50:50 or 60:40 or the reverse.

14.0 GUIDELINES ON MANDATORY SKILLS QUALIFICATIONS (MSQ)

Please, refer to NBTE guidelines for implementation of MSQ in Polytechnics. This can be downloaded from NBTE website (web.nbte.gov.ng)



CURRICULUM TABLE**YEAR I SEMESTER I**

S/N	COURSE CODE	COURSE TITLE	L	T	P	CU	CH
1.	GNS 301	Use of English III	2	0	0	2	2
2.	MSQ 311	Principles of Quality Assurance Assessment	1	0	1	2	2
3.	WPT 311	Advanced Wood Anatomy and Commercial Timber Identification	1	0	3	4	4
4.	WPT 312	Wood Chemistry	1	0	2	3	3
5.	WPT 313	Advanced Wood Physics	1	0	2	3	3
6.	WPT 314	Timber Harvesting, Conversion and Processing Systems	1	0	3	4	4
7.	WPT 315	Wood Seasoning	1	0	3	4	4
8.	WPT 316	Computer Applications in Wood and Paper Technology	1	0	3	4	4
9.	WPT 317	Industrial Safety, Health and Environmental Management	1	0	2	3	3
10.	WPT 318	Climate Change and Forest Resources	1	0	1	2	2
TOTAL			11	0	20	31	31

YEAR I SEMESTER II

S/N	COURSE CODE	COURSE TITLE	L	T	P	CU	CH
1.	GNS 302	Communication in English III	2	0	0	2	2
2.	GNS 321	General Philosophy	2	0	0	2	2
3.	ENT 326	Practice of Entrepreneurship I	2	0	2	4	4
4.	MSQ 321	Practice of Quality Assurance Assessment	1	0	1	2	2
5.	AGR 302	Field Experimentation and Data Analysis	1	0	1	2	2
6.	WPT 321	Environmental Impact Assessment in Wood Production	1	0	1	2	2
7.	WPT 322	Advanced Sawmilling and Timber Processing Technology	1	0	3	4	4
8.	WPT 323	Forest Operations and Techniques	1	0	3	4	4
9.	WPT 324	Forest Certification and Timber Traceability	1	0	3	4	4
10.	WPT 325	Wood Waste Utilization and Circular Bioeconomy	1	0	3	4	4
11.	WPT 326	Biodeterioration of Wood	1	0	2	3	3
12.	WPT 327	Pulping Processes	1	0	2	3	3
TOTAL			15	0	21	36	36

YEAR II SEMESTER I

S/N	COURSE CODE	COURSE TITLE	L	T	P	CU	CH
1.	ENT 416	Practice of Entrepreneurship II	2	0	2	4	4
2.	AGR 401	Research Methodology and Scientific writing	1	0	1	2	2
3.	WPP 413	Yard Operations and Material Handling	1	0	2	3	3
4.	PPP 411	Paper Testing and Quality Control	1	0	3	4	4
5.	PPP 412	Paper Chemistry and Additives	1	0	2	3	3
6.	PPP 413	Process Control and Instrumentation	1	0	2	3	3
7.	PPP 414	Advanced Papermaking Technology	1	0	3	4	4
8.	PPP 415	Timber and Fibre Traceability Systems	1	0	3	4	4
9.	PPP 416	Advanced Pulping Technology	1	0	3	4	4
10.	PPP 417	Sustainable Packaging Design and Innovation	1	0	3	4	4
TOTAL			11	0	24	35	35

YEAR II SEMESTER II

S/N	COURSE CODE	COURSE TITLE	L	T	P	CU	CH
1.	GNS 411	Introduction to psychology	2	0	0	2	2
2.	PPP 421	Environmental Management in Pulp and Paper	1	0	2	3	3
3.	PPP 422	Business Management in Pulp and Paper Making	1	0	2	3	3
4.	PPP 423	Industry 4.0 Applications in Paper Making	1	0	3	4	4
5.	PPP 424	Pulp, Paper and Downstream Industry	1	0	2	3	3
6.	PPP 425	Packaging, Printing and Converting Technology	1	0	3	4	4
7.	PPP 426	Tissue and Specialty Paper Product Conversion Technology	1	0	3	4	4
8.	PPP 427	Recycled Fibre, Materials and Downstream Plant Operations	1	0	3	4	4
9.	PPP 428	Project	0	0	4	4	4
TOTAL			9	0	22	31	31



WOOD ANATOMY AND IDENTIFICATION

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)		
COURSE TITLE: WOOD ANATOMY AND IDENTIFICATION	COURSE CODE: WPT 311	CONTACT HOURS: 4HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 1HOUR/WEEK
YEAR: 1 SEMESTER:1	PRE-REQUISITE: NIL	PRACTICAL:3 HOURS/WEEK
GOAL: This course is designed to equip students with the knowledge and skills in anatomy and identification of wood.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand wood anatomy and structure 2.0 Comprehend commercial timber species using anatomical and physical characteristics 3.0 Understand the relationship between wood structure and utilization 4.0 Apply wood identification techniques for industrial and commercial purposes.		

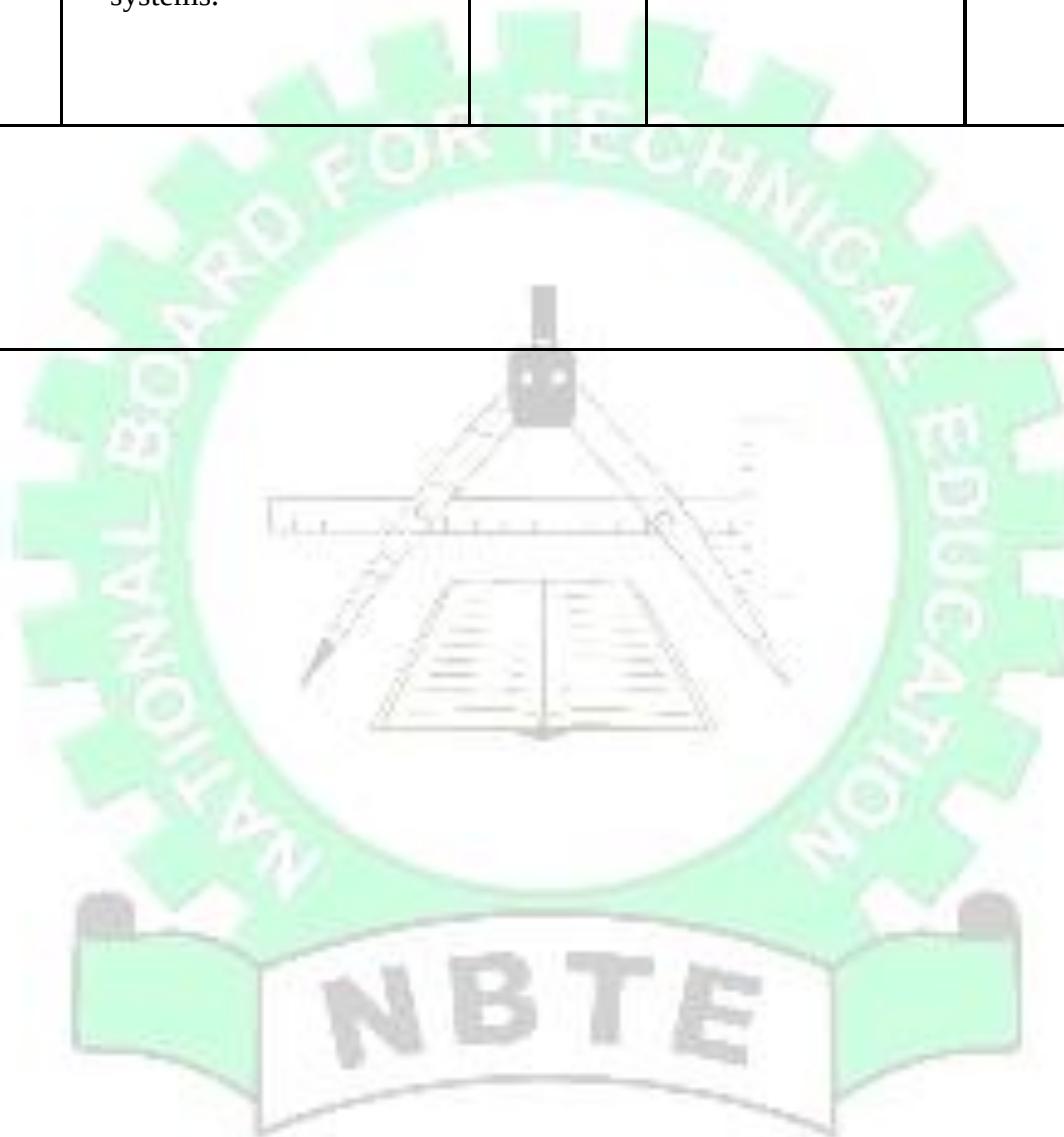
PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)						
COURSE TITLE: WOOD ANATOMY AND IDENTIFICATION		COURSE CODE: WPT 311			CONTACT HOURS: 4 HOURS/WEEK	
		CREDIT UNIT: 4			THEORETICAL:1HOUR/WEEK	
YEAR: I SEMESTER: I		PRE-REQUISITE: NIL			PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with the knowledge and skills in anatomy and identification of wood.						
GENERAL OBJECTIVE 1.0: Understand wood anatomy and structure						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1-3	1.1 Describe the internal structure of wood: • Pith • Bark • Cambium • Sapwood • Heartwood 1.2 Differentiate between hardwood and softwood. 1.3 Define the following terms: • annual rings • pores • rays • canal zones. 1.4 Explain growth rings and grain patterns using local species	• Explain wood structure using diagrams and wood samples. • Distinguish between hardwood and softwood. • Explain the term annual rings, pores, rays and canal zones. • Explain growth rings and grain patterns • Explain cellular components of hardwoods and softwoods • Distinguish between macroscopic and microscopic wood anatomy. • Explain wood grain		• Identify wood anatomical parts; e. g Micro and macro parts for different wood species. • Identify growth increments using hand lens or microscope. • Identify annual rings, pores, rays and canal zones.	Guide student to: • Identify wood anatomical parts; e. g Micro and macro parts for different wood species. • Identify growth increments using hand lens or microscope. • Identify annual rings, pores, rays and canal zones.	Timber specimens, Razor blade, Hand lens, Microscope, Practical manual, Measuring tools, PPEs, Petri dishes Wood dissecting kits Cover slips Slides Wash bottles Lactophenol

	examples. 1.5 Describe cellular components of hardwoods and softwoods: •Vessels •Fibres •Parenchyma •Tracheid •Rays 1.6 Distinguish between macroscopic and microscopic wood anatomy. 1.7 Describe wood grain characteristics and growth patterns. 1.8 Explain factors affecting wood formation and structure.	characteristics and growth patterns • State factors affecting wood formation and structure.				
General Objective 2.0: Understand the microscopic anatomical features of wood.						
4-7	2.1 Define, wood microscopic structures such as parenchyma, collenchyma, sclerenchyma, phloem, xylem etc. 2.2 Explain the structures above in 2.1 2.3 Describe the	• Explain wood microscopic structures such as; parenchyma, collenchyma, sclerenchyma, phloem, xylem etc. • Explain the arrangements and functions of cells of the structures identified in 2.1. above		• Identify wood microscopic structures such as parenchyma, collenchyma, sclerenchyma, phloem, xylem etc.	Guide student to: • Identify wood microscopic structures such as parenchyma, collenchyma, sclerenchyma, phloem, xylem etc.	Wood anatomy charts, Wood cross-sections, Microscope, projector, Timber

	arrangements and functions of cells of the structures identified in 2.2 above.	Describe the arrangements and functions of cells of the structures identified in 2.2 above				
General Objective 3.0: Comprehend commercial timber species using anatomical and physical characteristics						
8-11	3.1 Describe major indigenous timber species and their characteristics 3.2 Describe major exotic timber species: Teak, Gmelina, Pine, Eucalyptus etc. 3.3 Explain physical properties of wood: colour, texture, odour, density, hardness and grain. 3.4 Explain the use of botanical and local names in timber identification. 3.5 Classify timber species based on physical and structural properties. 3.6 Describe the use of these commercial timbers identified in 3.5 above based on their characteristics	- Discuss major indigenous timber species and their characteristics: e.g Iroko, Mahogany, Obeche, Opepe, Afara, Apa - Discuss major exotic timber species: Teak, Gmelina, Pine, Eucalyptus etc. - Explain physical properties of wood: colour, texture, odour, density, hardness and grain. - Explain the use of botanical and local names in timber identification. - Classify timber species based on physical and structural properties.		- Identify at least 30 hard wood timber species using the presence of such features as ray cells, parenchyma, pores, canals, sapwood colour and depth, heartwood colour and annual rings, etc. - Identify at least 5 soft wood timber species using the presence of such features as ray cells, parenchyma, pores, canals, sapwood colour and depth, heartwood colour and annual rings, etc. - Identify exotic timber species and their characteristics	Guide students to: - Identify at least 30 hard wood timber species using the presence of such features as ray cells, parenchyma, pores, canals, sapwood colour and depth, heartwood colour and annual rings, etc. - Identify at least 5 soft wood timber species using the presence of such features as ray cells, parenchyma, pores, canals, sapwood colour and depth,	Timber samples, weighing balance, Density measuring tools, Timber identification guide, Practical manual etc.

	such as working properties, density, etc.			• Cut wood sections and mount same on slides. • Identify gross wood feature visually or with microscope • Identify wood species using dichotomous key card system	heartwood colour and annual rings, etc. • Identify exotic timber species and their characteristics • Cut wood sections and mount same on slides. • Identify gross wood feature visually or with microscope • Identify wood species using dichotomous key card system	
General Objective 4.0: Apply wood identification techniques for industrial and commercial purposes						
12-15	4.1 Explain standard procedures for timber identification in industries. 4.2 Explain the role of timber identification in quality control and marketing. 4.3 Explain digital tools used in timber identification and inventory systems.	• Discuss standard procedures for timber identification in industries. • Explain the role of timber identification in quality control and marketing. • Explain digital tools used in timber identification and inventory systems. • Explain timber traceability and documentation		• Identify wood species using dichotomous key card system • Carry out a Visit to a timber industry to identify relevant industrial machineries	Guide student to: • Identify wood species using dichotomous key card system • Carry out a Visit to a timber industry to identify relevant industrial machineries	Timber market/sawmill, Hand lens, Timber catalogue, Smartphones, , Practical manual Etc.

	4.4 Explain timber traceability and documentation systems.	systems.				
COURSE ASSESSMENT Coursework: 10% Tests: 10% Practical: 40% Examination: 40% Total: 100%						



WOOD CHEMISTRY

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)		
COURSE TITLE: WOOD CHEMISTRY	COURSE CODE: WPT 312	CONTACT HOURS: 3HOURS/WEEK
	CREDIT UNIT: 3	THEORETICAL: 1HOUR/WEEK
YEAR: 1 SEMESTER:1	PRE-REQUISITE: NIL	PRACTICAL:2 HOURS/WEEK
GOAL: This course is designed to provide students with knowledge and skills in wood chemical composition, properties, and extraction processes.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand wood components and the preparation of lignin, Cellulose derivatives and furfural; 2.0 Know the determination of the total extractive contents of wood; 3.0 Understand the physical and chemical properties of wood and their industrial implications.		



PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)						
COURSE TITLE: WOOD CHEMISTRY			COURSE CODE: WPT 312		CONTACT HOURS: 3HOURS/WEEK	
			CREDIT UNIT: 3		THEORETICAL: 1HOUR/WEEK	
YEAR: 1 SEMESTER:1			PRE-REQUISITE: NIL		PRACTICAL:2 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to provide students with knowledge and skills in wood chemical composition, properties, and extraction processes.						
GENERAL OBJECTIVE 1.0: Understand wood components and the preparation of lignin, cellulose derivatives and furfural						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1–5	1.1 List major wood components, 1.2 Describe physical and chemical properties of major wood components in 1.1 above 1.3 Describe isolation of the major wood components listed in 1.1 above 1.4 Describe the derivatives, uses and importance of the components isolated in 1.3 above 1.5 Explain the term Technical Association	• State major wood components, e.g. cellulose, hemicellulose, lignin. • Explain physical and chemical properties of major wood components • Explain isolation of the major wood components describe in 1.1 above • Explain the derivatives, uses and importance of the components isolated in 1.3 above • Explain the term TAPPI standard.		• Isolate the major wood components describe in 1.1 above • Prepare cellulose nitrate, alkali-cellulose • Prepare furfural in the laboratory. • Isolate lignin from wood	Guide student to; • Isolate the major wood components describe in 1.1 above • Prepare cellulose nitrate, alkali- cellulose • Prepare furfural in the laboratory. • Isolate lignin from wood	Wood samples

	of the Pulp and Paper Industry (TAPPI) standard. 1.6 Describe the preparation of cellulose nitrate, alkali- cellulose 1.7 List the uses of the products in 1.6 above. 1.8 Describe the laboratory preparation of furfural 1.9 Explain the uses of furfural 1.10 Describe the preparation of furfural in the laboratory. 1.11 Define lignin. 1.12 Describe lignin from wood 1.13 Describe isolation of lignin from wood	• Explain the preparation of cellulose nitrate, alkali- cellulose • State the uses of the products in 1.6 above • Explain the laboratory preparation of furfural • Explain the uses of furfural • Explain the preparation of furfural in the laboratory. • Explain lignin • Explain lignin from wood • Explain isolation of lignin from wood				
General Objective 2.0: Know the determination of the total extractive contents of wood						

6-10	2.1 Explain the use of chromatography, thin layer chromatography in the determination of total extractive contents of wood 2.2 Describe determination total extractive contents of wood 2.3 Describe the method of isolation of wood 2.4 Describe minor wood components and reducing sugars.	• Explain the use of chromatography, thin layer chromatography in the determination of total extractive contents of wood • Explain determination total extractive contents of wood • Explain the method of isolation of wood • Explain minor wood components and reducing sugars.	Charts Projector	• Determine total extractive contents of wood	Guide student to: Determine total extractive contents of wood	Wood samples
General Objective 3.0: Understand the effects of heat, chemicals, light and powerful rays on wood						
11-15	3.1 Describe the reaction of wood when heated at various temperatures. 3.2 Describe preparation of charcoal from wood. 3.3 Describe determination the ash content of charcoal 3.4 Compare the heat values of wood with those of other energy sources. 3.5 Compare the	• Explain the reaction of wood when heated at various temperatures. • Explain preparation of charcoal from wood • Explain determination the ash content of charcoal • Compare the heat values of wood with those of other energy sources. • Compare the properties of wood to those of other construction	Charts Projector	• Prepare charcoal from wood. • Determine the ash content of charcoal • Compare the heat values of wood with those of other energy sources. • Compare the properties of wood to those of other construction materials in relation to their respective resistance to chemical attack	Guide student to: • Prepare charcoal from wood. • Determine the ash content of charcoal • Compare the heat values of wood with those of other energy sources. • Compare the properties of wood to those of other construction materials in relation to their respective resistance to chemical attack	Wood samples

	properties of wood to those of other construction materials in relation to their respective resistance to chemical attack. 3.6 Describe the effect of light and strong gamma rays on the properties of wood and wood products. 3.7 Explain the concept of fixation of toxic chemical in wood.	materials in relation to their respective resistance to chemical attack • Explain the effect of light and strong gamma rays on the properties of wood and wood products. • Explain the concept of fixation of toxic chemical in wood.				
COURSE ASSESSMENT Coursework: 10% Tests: 10% Practical: 40% Examination: 40% Total: 100%						

WOOD PHYSICS

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)		
COURSE TITLE: WOOD PHYSICS	COURSE CODE: WPT 313	CONTACT HOURS: 3 HOURS/WEEK
	CREDIT UNIT: 3	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: I	PRE-REQUISITE: NIL	PRACTICAL: 2 HOURS/WEEK
GOAL: The course is designed to equip students with the knowledge and skills of the physical properties of wood.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the methods of determination of wood density at various moisture content levels 2.0 Know the effect of moisture content of wood on its physical properties and usage 3.0 Know the anisotropic behavior of wood in both aqueous and non-aqueous liquids 4.0 Understand the process of diffusion in wood and factors affecting it 5.0 Know the influence of wood structure, density moisture content on thermal conductivity of wood 6.0 Understand the electrical properties of wood.		

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)						
COURSE TITLE: WOOD PHYSICS		COURSE CODE: WPT 313		CONTACT HOURS: 3 HOURS/WEEK		
		CREDIT UNIT: 3		THEORETICAL: 1 HOUR/WEEK		
YEAR: I SEMESTER: I		PRE-REQUISITE: NIL		PRACTICAL: 2 HOURS/WEEK		
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: The course is designed to equip students with the knowledge and skills of the physical properties of wood.						
GENERAL OBJECTIVE 1.0: Understand the methods of determination of wood density at various moisture content levels.						
THEORETICAL				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1–3	1.1 Explain wood density types. 1.2 Describe density measurement of irregular wood samples with a Breuil apparatus. 1.3 Describe the effect of moisture content on wood density. 1.4 Explain the green-wood density relationship. 1.5 Explain the calculation of density of green wood.	- Discuss wood density types. - Explain density measurement of irregular wood samples with a Breuil apparatus. - Explain the effect of moisture content on wood density. - Discuss the green-wood density relationship.	wood physics textbooks, formula sheets, property charts, wood standards, worked examples, computer, projector, internet resources.	- Determine the exact density of irregularly shaped wood sample by immersion in suitable liquid media, using Breuil apparatus. - Calculate the density of green wood. - Demonstrate different types of density of wood. Such as bulk density, packing density, oven dry	- Determine the exact density of irregularly shaped wood sample by immersion in suitable liquid media, using Breuil apparatus. - Calculate the density of green wood. - Demonstrate different types of density of wood. Such as bulk density, packing density, oven dry	wood specimens, balance, callipers, moisture meter, oven, Breuil apparatus, electrical test instruments, data sheets, PPE.

		Discuss the calculation of density of green wood.		density etc. - Classify wood density types using selected samples. - Test density measurement of irregular wood samples with a Breuil apparatus with appropriate equipment. - Test the effect of moisture content on wood density with appropriate equipment.	density etc. - Classify wood density types using selected samples. - Test density measurement of irregular wood samples with a Breuil apparatus with appropriate equipment. - Test the effect of moisture content on wood density with appropriate equipment.	
General Objective 2.0: Know the effect of moisture content of wood on its physical properties and usage.						
4-7	2.1 Explain effects of moisture content on wood properties. 2.2 Explain moisture effects on wood biodeterioration. 2.3 Describe the measurement of moisture content of wood using the hygrometric	- Discuss effects of moisture content on wood properties. - Discuss moisture effects on wood biodeterioration. - Explain the measurement of moisture content of wood	wood physics textbooks, formula sheets, property charts, wood standards, worked examples, computer, projector, internet resources.	- Measure the moisture content of wood using the hygrometric and electrical methods. - Compare the two methods. - Assess the effect of moisture content of wood on its susceptibility to biodeterioration. - Document the	- Measure the moisture content of wood using the hygrometric and electrical methods. - Compare the two methods. - Assess the effect of moisture content of wood on its susceptibility to	wood specimens, balance, callipers, moisture meter, oven, Breuil apparatus, electrical test instruments, data sheets, PPE.

	and electrical methods. 2.4 Describe the thermodynamics of absorption.	using the hygrometric and electrical methods. Explain the thermodynamic s of absorption.		thermodynamics of absorption. Test effects of moisture content on wood properties with appropriate equipment.	biodeterioration. - Document the thermodynamics of absorption. - Test effects of moisture content on wood properties with appropriate equipment.	
General Objective 3.0: Know the anisotropic behaviour of wood in both aqueous and non-aqueous liquids.						
8–9	3.1 Describe anisotropic swelling and shrinkage of wood. 3.2 Describe components of wood swelling. 3.3 Describe the swelling of wood in aqueous and non-aqueous liquids. 3.4 Explain the dimensional stabilization in wood. 4.0 3.5 Describe the effect of restraining the movement of wood during swelling or	- Explain anisotropic swelling and shrinkage of wood. - Explain components of wood swelling. - Explain the swelling of wood in aqueous and non-aqueous liquids. - Discuss the dimensional stabilization in wood. - Explain the effect of restraining the movement of wood during swelling or shrinkage.	wood physics textbooks, formula sheets, property charts, wood standards, worked examples, computer, projector, internet resources.	- Measure radial, tangential and longitudinal swelling and shrinkage of selected wood specimens after exposure to aqueous and non-aqueous liquids. - Calculate percentage dimensional change and the anisotropy ratio for each specimen. - Demonstrate the effect of mechanical restraint and a selected	- Measure radial, tangential and longitudinal swelling and shrinkage of selected wood specimens after exposure to aqueous and non-aqueous liquids. - Calculate percentage dimensional change and the anisotropy ratio for each specimen. - Demonstrate the effect of mechanical	wood specimens, balance, callipers, moisture meter, oven, Breuil apparatus, electrical test instruments, data sheets, PPE.

	shrinkage.			dimensional-stabilisation treatment on wood movement. • Compare the experimental results. • Prepare a concise practical report. • Analyse an assigned practical case on anisotropic swelling and shrinkage of wood.	restraint and a selected dimensional-stabilisation treatment on wood movement. • Compare the experimental results. • Prepare a concise practical report. • Analyse an assigned practical case on anisotropic swelling and shrinkage of wood.	
General Objective 4.0: Understand the process of diffusion in wood and factors affecting it						
10–11	4.1 State the meaning of permeability of wood. 4.2 Describe the diffusion of water in solid wood and its effects on the drying process of wood. 4.3 Describe the non-pressure and pressure aspects of	• Outline the meaning of permeability of wood. • Explain the diffusion of water in solid wood and its effects on the drying process of wood. • Explain the non-pressure and pressure aspects of wood impregnation.	wood physics textbooks, formula sheets, property charts, wood standards, worked examples, computer, projector, internet resources.	• Prepare a concise illustrated summary of permeability of wood. • Simulate the diffusion of water in solid wood and its effects on the drying process of wood using the approved procedure. • Record observations.	• Prepare a concise illustrated summary of permeability of wood. • Simulate the diffusion of water in solid wood and its effects on the drying process	wood specimens, balance, callipers, moisture meter, oven, Breuil apparatus, electrical test instruments, data sheets, PPE.

	wood impregnation.			- Document the non-pressure and pressure aspects of wood impregnation. - Analyse an assigned practical case on permeability of wood.	- of wood using the approved procedure. - Record observations. - Document the non- pressure and pressure aspects of wood impregnation. - Analyse an assigned practical case on permeability of wood.	
General Objective 5.0: know the influence of wood structure, density, moisture content on thermal conductivity of wood						
12–13	5.1 Describe the influence of wood structure, density, moisture content and temperature on thermal conductivity of wood. 5.2 State the meaning of thermal diffusivity of wood. 5.3 Explain time-temperature relationship for	- Explain the influence of wood structure, density, moisture content and temperature on thermal conductivity of wood. - Outline the meaning of thermal diffusivity of wood. - Discuss time-temperature relationship for	wood physics textbooks, formula sheets, property charts, wood standards, worked examples, computer, projector, internet resources.	- Document the influence of wood structure, density, moisture content and temperature on thermal conductivity of wood. - Document the radiation of thermal energy in wood. - Analyse an assigned practical case on thermal diffusivity of wood. - Test time-	- Document the influence of wood structure, density, moisture content and temperature on thermal conductivity of wood. - Document the radiation of thermal energy in wood. - Analyse an assigned practical	wood specimens, balance, callipers, moisture meter, oven, Breuil apparatus, electrical test instruments, data sheets, PPE.

	thermal conductivity of wood using thermal diffusivity. 5.4 Describe the radiation of thermal energy in wood.	thermal conductivity of wood using thermal diffusivity. • Explain the radiation of thermal energy in wood.		temperature relationship for thermal conductivity of wood using thermal diffusivity with appropriate equipment. • Record observations in the practical logbook.	case on thermal diffusivity of wood. • Test time-temperature relationship for thermal conductivity of wood using thermal diffusivity with appropriate equipment. • Record observations in the practical logbook.	
General Objective 6.0: Understand the electrical properties of wood						
14-15	6.1 Explain the effects of direct current on wood properties. 6.2 Explain the determination of the electrical resistance of wood and hence its conductivity. 6.3 Explain the effects of alternating current	• Discuss the effects of direct current on wood properties. • Discuss the determination of the electrical resistance of wood and hence its conductivity.	wood physics textbooks, formula sheets, property charts, wood standards, worked examples, computer, projector, internet resources.	• Determine the electrical resistance of wood and hence its conductivity. • Calculate the radio-frequency rate of drying wood using its dielectric properties. • Analyse supplied data on the effects of direct current on wood properties.	• Determine the electrical resistance of wood and hence its conductivity. • Calculate the radio- frequency rate of drying wood using its dielectric properties. • Analyse supplied data on the	wood specimens, balance, callipers, moisture meter, oven, Breuil apparatus, electrical test instruments, data sheets, PPE.

	on wood properties. 6.4 Describe the resistivity and dielectric properties of wood. 6.5 Explain the method for calculating the radio- frequency rate of drying wood using its dielectric properties.	• Discuss the effects of alternating current on wood properties. • Explain the resistivity and dielectric properties of wood. • Discuss the method for calculating the radio- frequency rate of drying wood using its dielectric properties.		• Interpret the findings. • Test the effects of direct current on wood properties with appropriate equipment. • Test the resistivity and dielectric properties of wood with appropriate equipment.	effects of direct current on wood properties. • Interpret the findings. • Test the effects of direct current on wood properties with appropriate equipment. • Test the resistivity and dielectric properties of wood with appropriate equipment.	
COURSE ASSESSMENT Coursework: 10% Tests: 10% Practical: 40% Examination: 40% Total: 100%						

TIMBER HARVESTING, CONVERSION AND PROCESSING SYSTEM

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)		
COURSE TITLE: TIMBER HARVESTING, CONVERSION AND PROCESSING SYSTEM	COURSE CODE: WPT 314	CONTACT HOURS: 4HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 1HOUR/WEEK
YEAR: HND 1 SEMESTER:1	PRE-REQUISITE: NIL	PRACTICAL:3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills in timber harvesting, log conversion, sawmilling operations and timber processing systems.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand timber harvesting systems and operations; 2.0 Understand log handling and transportation systems; 3.0 Understand timber conversion methods and sawmilling processes; 4.0 Understand timber processing systems and machine operations; 5.0 Apply timber harvesting, conversion and processing techniques in industrial operations.		

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)						
COURSE TITLE: TIMBER HARVESTING, CONVERSION AND PROCESSING SYSTEM		COURSE CODE: WPT 314		CONTACT HOURS: 4HOURS/WEEK		
		CREDIT UNIT: 4		THEORETICAL: 1HOUR/WEEK		
YEAR: I SEMESTER: I		PRE-REQUISITE: NIL		PRACTICAL: 3HOURS/WEEK		
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with advanced knowledge and practical competencies in timber harvesting, log conversion, sawmilling operations and timber processing system.						
GENERAL OBJECTIVE 1.0: Understand timber harvesting systems and operations						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1–3	1.1 Explain timber harvesting systems and operations. 1.2 Describe stages of timber harvesting 1.3 Explain manual and mechanized harvesting methods. 1.4 Describe environmental and safety considerations in timber harvesting. 1.5 Explain sustainable timber harvesting principles.	- Describe timber harvesting systems and operations. - Explain stages of timber harvesting - Discuss manual and mechanized harvesting methods. - Explain environmental and safety considerations in timber harvesting. - Discuss sustainable timber harvesting	Harvesting charts, logging videos, timber harvesting manuals, projector, textbooks etc.	- Identify timber harvesting tools and equipment. - Demonstrate safe handling of hand tools used in timber harvesting. - Observe tree felling techniques through field demonstration/video and record stages. - Prepare harvesting operation report.	Guide students to: - Identify timber harvesting tools and equipment. - Demonstrate safe handling of hand tools used in timber harvesting. - Observe tree felling techniques through field demonstration/video and record stages. - Prepare harvesting operation report.	Harvesting tools, PPE, Videos, Field Practical manual.

		principles.				
General Objective 2.0: Understand log handling and transportation systems						
4–5	2.1 Describe log handling methods after harvesting. 2.2 Explain log extraction systems: skidding, hauling and loading. 2.3 Explain log storage and preservation during transportation. 2.4 Describe factors affecting log quality during handling and transportation.	• Explain log handling methods after harvesting. • Discuss log extraction systems: skidding, hauling and loading. • Describe log storage and preservation during transportation. • Discuss factors affecting log quality during handling and transportation.	Log handling charts, transportation videos, Timber samples, Projector, Textbooks etc.	• Measure log dimensions • Estimate log volume. • Identify log defects associated with poor handling and transportation. • Compare properly handled and poorly handled timber logs.	Guide student to: • Measure log dimensions • Estimate log volume. • Identify log defects associated with poor handling and transportation. • Compare properly handled and poorly handled timber logs.	Timber logs, Measuring tape, Log scale, calculator, , practical manual.
General Objective 3.0: Understand timber conversion methods and sawmilling processes						
6–9	3.1 Explain timber conversion methods 3.2 Describe sawmilling processes and workflow. 3.3 Explain types of saws used in timber conversion. 3.4 Describe timber recovery and conversion efficiency.	• Discuss timber conversion methods: • Explain sawmilling processes and workflow. • Discuss types of saws used in timber conversion. • Explain timber	Sawmill videos, Timber conversion charts, Timber specimens, Projector, Textbooks	• Identify sawmill machines and saw types. • Demonstrate timber conversion patterns using timber blocks. • Calculate timber recovery percentage from processed	Guide student to: • Identify sawmill machines and saw types • Demonstrate timber conversion	Timber blocks, Sawmill Layout charts, Measuring tape, Calculators, Practical

	3.5 Explain causes of conversion defects and waste generation	recovery and conversion efficiency. • Discuss causes of conversion defects and waste generation.	Etc.	timber. • Identify defects arising during timber conversion.	patterns using timber blocks. • Calculate timber recovery percentage from processed timber. • Identify defects arising during timber conversion.	manual
General Objective 4.0: Understand timber processing systems and machine operations						
10–12	4.1 Explain timber processing systems in wood industries. 4.2 Describe timber processing machines and their functions. 4.3 Explain machine operation principles and maintenance requirements 5.0 4.4 Describe safety precautions in timber processing operations.	• Discuss timber processing systems in wood industries. • Discuss timber processing machines and their functions. • Discuss machine operation principles and maintenance requirements • Explain safety precautions in timber processing operations.	Workshop machines, Processing charts, Maintenance manuals, projector, Textbooks Etc.	• Identify timber processing machines and their components. • Demonstrate safe operation of selected workshop machines. • Observe machine maintenance procedures. • Prepare machine operation checklist.	Guide students to: • Identify timber processing machines and their components. • Demonstrate safe operation of selected workshop machines. • Observe machine maintenance procedures. • Prepare machine operation	Timber blocks, Sawmill Layout charts, Measuring tape, Calculators, Practical manual

					checklist.	
General Objective 5.0: Apply timber harvesting, conversion and processing techniques in industrial operations						
13–15	5.1 Describe industrial timber processing workflow. 5.2 Explain quality considerations in timber harvesting and processing. 5.3 Describe timber waste reduction practices. 5.4 Explain emerging trends in timber harvesting and processing systems.	• Explain industrial timber processing workflow. • Describe quality considerations in timber harvesting and processing. • Explain timber waste reduction practices. • Discuss emerging trends in timber harvesting and processing systems.	Industrial processing charts, Sawmill videos, Projector, Textbooks Etc.	• Visit sawmill or timber processing industry and • Observe harvesting-to-processing workflow. • Measure processed timber • Estimate recovery efficiency. • Assess timber quality and identify processing defects	Guide students to: • Visit sawmill or timber processing industry and • Observe harvesting-to-processing workflow. • Measure processed timber • Estimate recovery efficiency. • Assess timber quality and identify processing defects	Sawmill/timber processing facility, Measuring tape, Calculator, t, Practical manual.
COURSE ASSESSMENT Coursework: 10% Tests: 10% Practical: 40% Examination: 40% Total: 100%						

WOOD SEASONING

PROGRAMME: NATIONAL DIPLOMA IN WOOD AND WOOD PROCESSING TECHNOLOGY		
COURSE TITLE: WOOD SEASONING	COURSE CODE: WPT 315	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: I	PRE-REQUISITE: NIL	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills of principles and techniques of wood seasoning.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the theory of wood seasoning. 2.0 Understand the principles and techniques of various wood seasoning methods. 3.0 Know the different methods of veneer drying.		



PROGRAMME: NATIONAL DIPLOMA IN WOOD AND WOOD PROCESSING TECHNOLOGY						
COURSE TITLE: WOOD SEASONING		COURSE CODE: WPT 315		CONTACT HOURS: 4 HOURS/WEEK		
		CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK		
YEAR: I SEMESTER: I		PRE-REQUISITE: NIL		PRACTICAL: 3 HOURS/WEEK		
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to provide students with the knowledge and skills of principles and techniques of wood seasoning.						
GENERAL OBJECTIVE 1.0: Understand the theory of wood seasoning						
THEORETICAL				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1-4	1.1 Explain seasoning to include moisture content reduction and minimizing drying defects. 1.2 Explain moisture content of wood 1.3 Describe Equilibrium Moisture Content (EMC) distribution in Nigeria. 1.4 Explain moisture gradient mathematically and its effects on the rate of drying.	• Discuss seasoning to include moisture content reduction and minimizing drying defects using relevant examples, diagrams and illustrations. • Discuss moisture content of wood • Explain Equilibrium Moisture Content (EMC) distribution in Nigeria using relevant examples, diagrams and illustrations. • Discuss moisture gradient mathematically and its	wood-seasoning textbooks, kiln diagrams, psychrometric charts, drying schedules, technical standards, computer, projector, internet resources.	• Determine the initial and final moisture content of wood specimens using oven-dry and electrical moisture-meter methods. • Calculate moisture loss, moisture gradient and equilibrium moisture content from supplied temperature and relative-humidity data.	Guide students to: • Determine the initial and final moisture content of wood specimens using oven-dry and electrical moisture-meter methods. • Calculate moisture loss, moisture gradient and equilibrium moisture content from supplied temperature and relative-humidity data. • Inspect the	wood specimens, drying oven, moisture meter, kiln or kiln model, thermometers, hygrometer, psychrometric chart, data sheets, PPE.

		effects on the rate of drying using relevant examples, diagrams and illustrations.		- Inspect the seasoned specimens - Identify drying defects and recommend corrective measures.	seasoned specimens Identify drying defects and recommend corrective measures.	
General Objective 2.0: Understand the principles and techniques of various wood seasoning methods						
5-10	2.1 Describe the major wood seasoning methods 2.2 Outline air-seasoning yard layout requirements for efficient drying. 2.3 Describe conventional and accelerated air-drying methods. 2.4 Explain kiln types, design features, instrumentation and operating controls. 2.5 Describe the effects of temperature, relative humidity, air circulation and	- Explain the major wood seasoning methods - Explain air-seasoning yard layout, foundation, stacking and ventilation requirements for efficient drying - Discuss conventional and accelerated air-drying methods. - Discuss kiln types, kiln design features, instrumentation and operating controls - Explain the analytical procedure and interpretation of the effects of temperature, relative humidity, air circulation and	wood-seasoning textbooks, kiln diagrams, psychrometric charts, drying schedules, technical standards, computer, projector, internet resources.	- Prepare a scaled layout of an air-seasoning yard showing foundations, stacks, spacing, drainage and access routes. - Arrange a timber stack using correct foundations, stickers, restraints and ventilation provisions. - Operate or simulate a kiln-drying cycle using an approved drying schedule and	Guide students to: - Prepare a scaled layout of an air-seasoning yard showing foundations, stacks, spacing, drainage and access routes. - Arrange a timber stack using correct foundations, stickers, restraints and ventilation provisions. - Operate or simulate a kiln-drying cycle using an approved drying schedule and	wood specimens, drying oven, moisture meter, kiln or kiln model, thermometers, hygrometer, psychrometric chart, data sheets, PPE.

	steaming on kiln drying. 2.6 Explain drying progress using sample weighing, automatic controls, time controllers and drying schedules. 2.7 Describe alternative seasoning methods.	steaming on kiln drying using worked • Explain the analytical procedure and interpretation of drying progress. • Discuss the criteria and evidence required to evaluate alternative seasoning methods		record temperature, humidity and moisture-content readings. • Plot drying progress from recorded data • Identify deviations from the selected drying schedule. • Compare kiln, solar, dehumidification and radio-frequency drying methods using specified performance criteria.	record temperature, humidity and moisture-content readings. • Plot drying progress from recorded data • Identify deviations from the selected drying schedule. • Compare kiln, solar, dehumidification and radio-frequency drying methods using specified performance criteria.	
General Objective 3.0: Know the different methods of veneer drying.						
11-15	3.1 Outline different joints made with adhesives, bolts, screws and gusset plates. 3.2 Explain the principle of veneer drying. 3.3 Explain veneer	• Explain different joints made with adhesives, bolts, screws and gusset plates with relevant examples, diagrams or case materials. • Discuss the principle of veneer drying using	wood-seasoning textbooks, kiln diagrams, psychrometric charts, drying schedules, technical standards, computer,	• Draw different joints made with adhesives, bolts, screws and gusset plates. • Calculate conventional veneer drying time.	Guide students to: • Draw different joints made with adhesives, bolts, screws and gusset plates. • Calculate conventional veneer drying time.	wood specimens, drying oven, moisture meter, kiln or kiln model, thermometers, hygrometer, psychrometric

	quality control during drying. 3.4 Describe the methods of veneer drying 3.5 Explain conventional veneer drying time.	relevant examples, diagrams and illustrations. • Discuss veneer quality control during drying • Discuss the methods of veneer drying • Discuss conventional veneer drying time.	projector, internet resources.	• Dry veneer applying any of the methods already described. • Demonstrate or model the principle of veneer drying through an assigned practical exercise. • Demonstrate or model veneer quality control during drying through an assigned practical exercise.	• Dry veneer applying any of the methods already described. • Demonstrate or model the principle of veneer drying through an assigned practical exercise. • Demonstrate or model veneer quality control during drying through an assigned practical exercise.	chart, data sheets, PPE.
COURSE ASSESSMENT Coursework: 10% Tests: 10% Practical: 40% Examination: 40% Total: 100%						

COMPUTER APPLICATIONS IN WOOD AND PAPER TECHNOLOGY

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)		
COURSE TITLE: COMPUTER APPLICATIONS IN WOOD AND PAPER TECHNOLOGY	COURSE CODE: WPT 316	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: HND 1 SEMESTER:1	PRE-REQUISITE: NIL	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills in computer applications, digital tools and information systems relevant to wood and paper technology.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand computer applications in wood and paper technology; 2.0 Know computer tools for timber calculations and data management; 3.0 Know digital tools for wood products design and documentation; 4.0 Know computer applications in production, inventory and industrial operations.		

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)						
COURSE TITLE: COMPUTER APPLICATIONS IN WOOD AND PAPER TECHNOLOGY		COURSE CODE: WPT 316		CONTACT HOURS: 4 HOURS/WEEK		
		CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK		
YEAR: I SEMESTER: I		PRE-REQUISITE: NIL		PRACTICAL: 3 HOURS/WEEK		
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills in computer applications, digital tools and information systems relevant to wood and paper technology.						
GENERAL OBJECTIVE 1.0: Understand computer applications in wood and paper technology;						
THEORETICAL				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1–3	1.1 Explain the role of computers in wood and paper industries. 1.2 Describe computer applications in timber processing, inventory, production and quality control. 1.3 Describe digital information systems used in wood industries. 1.4 Explain the importance of ICT in industrial operations and reporting.	•Discuss the role of computers in wood and paper industries •Explain computer applications in timber processing, inventory, production and quality control •Discuss digital information systems used in wood industries •Discuss the importance of ICT in industrial operations and reporting.	computer systems, application-software manuals, sample datasets, digital templates, projector, computer, internet resources.	• Identify hardware and software used in wood industries • Access online timber information databases and digital catalogues. • Demonstrate or model the role of computers in wood and paper industries through an assigned practical exercise. • Demonstrate or simulate computer	Guide students to: • Identify hardware and software used in wood industries • Access online timber information databases and digital catalogues. • Demonstrate or model the role of computers in	computers, spreadsheet software, CAD or drawing software, database software, sample production data, printer.

				applications in timber processing, inventory, production and quality control.	wood and paper industries through an assigned practical exercise. • Demonstrate or simulate computer applications in timber processing, inventory, production and quality control.	
General Objective 2.0: Know computer tools for timber calculations and data management						
4–7	2.1 Describe computer applications in timber volume 2.2 Explain spreadsheet functions for timber measurement and costing. 2.3 Describe digital record keeping and database management. 2.4 Explain computer applications in	• Explain computer applications in timber volume • Discuss spreadsheet functions for timber measurement and costing. • Explain digital record keeping and database management using relevant examples, diagrams and illustrations.	computer systems, application-software manuals, sample datasets, digital templates, projector, computer, internet resources.	• Use spreadsheet software to calculate timber volume and recovery percentage. • Prepare timber costing sheet using spreadsheet formulas. • Develop digital timber inventory records. • Prepare timber production data and summary report.	Guide students to: • Use spreadsheet software to calculate timber volume and recovery percentage. • Prepare timber costing sheet using spreadsheet formulas. • Develop digital timber inventory	computers, spreadsheet software, CAD or drawing software, database software, sample production data, printer.

	timber inventory management.	• Discuss computer applications in timber inventory management using relevant examples, diagrams and illustrations.			- records. • Prepare timber production data and summary report.	
General Objective 3.0: Know digital tools for wood product design and documentation						
8–11	3.1 Explain computer applications in wood product design and drafting. 3.2 Describe basic computer-aided design (CAD) concepts in wood industries. 3.3 Explain digital documentation procedures for production and quality control. 3.4 Explain digital communication tools used in wood industries.	• Discuss computer applications in wood product design and drafting • Explain basic computer-aided design (CAD) concepts in wood industries. • Discuss digital documentation procedures for production and quality control. • Discuss digital communication tools used in wood industries.	computer systems, application-software manuals, sample datasets, digital templates, projector, computer, internet resources.	• Prepare simple wood product sketches using computer drawing tools. • Develop digital production report for wood processing operation. • Prepare digital quality inspection checklist. • Design simple timber documentation template.	Guide students to: • Prepare simple wood product sketches using computer drawing tools. • Develop digital production report for wood processing operation. • Prepare digital quality inspection checklist. • Design simple timber documentation template.	computers, spreadsheet software, CAD or drawing software, database software, sample production data, printer.
General Objective 4.0: : Know computer applications in production, inventory and industrial operations						

12-15	4.1 Explain computer applications in production planning and monitoring. 4.2 Describe digital inventory systems in wood industries. 4.3 Explain computer applications in quality assurance and industrial reporting. 4.4 Describe emerging digital trends in wood and paper industries.	• Discuss computer applications in production planning and monitoring. • Discuss digital inventory systems in wood industries. • Describe s computer applications in quality assurance and industrial reporting. • Discuss emerging digital trends in wood and paper industries.	computer systems, application- software manuals, sample datasets, digital templates, projector, computer, internet resources.	• Prepare digital production schedule for timber processing. Develop computerized inventory system for timber products. • Visit sawmill or furniture workshop and assess digital record systems used. • Demonstrate or model computer applications in production planning and monitoring through an assigned practical exercise. • Use relevant software or digital tools to demonstrate digital inventory systems in wood industries and present the output.	Guide students to: • Prepare digital production schedule for timber processing. Develop computerized inventory system for timber products. • Visit sawmill or furniture workshop and assess digital record systems used. • Demonstrate or model computer applications in production planning and monitoring • Use relevant software or digital tools to demonstrate digital inventory systems in wood industries.	computers, spreadsheet software, CAD or drawing software, database software, sample production data, printer.
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COURSE ASSESSMENT

Coursework:	10%
Tests:	10%
Practical:	40%
Examination:	40%
Total:	100%



INDUSTRIAL SAFETY, HEALTH AND ENVIRONMENTAL MANAGEMENT

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)		
COURSE TITLE: INDUSTRIAL SAFETY, HEALTH AND ENVIRONMENTAL MANAGEMENT	COURSE CODE: WPT 317	CONTACT HOURS: 3 HOURS/WEEK
	CREDIT UNIT: 3	THEORETICAL: 1 HOUR/WEEK
YEAR: HND 1 SEMESTER:1	PRE-REQUISITE: NIL	PRACTICAL: 2 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and practical competencies in industrial safety, occupational health and environmental management practices for safe operations in wood and paper industries.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand principles of industrial safety and occupational health; 2.0 Know workshop and machine safety practices; 3.0 Know accident prevention, emergency response and fire safety protocols; 4.0 Understand environmental management practices in wood and paper industries;		

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)						
COURSE TITLE: INDUSTRIAL SAFETY, HEALTH AND ENVIRONMENTAL MANAGEMENT			COURSE CODE: WPT 317		CONTACT HOURS: 3 HOURS/WEEK	
			CREDIT UNIT: 3		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: I			PRE-REQUISITE: NIL		PRACTICAL: 2 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and practical competencies in industrial safety, occupational health and environmental management practices for safe operations in wood and paper industries.						
GENERAL OBJECTIVE 1.0: Understand principles of industrial safety and occupational health						
THEORETICAL				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1–3	1.1 Explain principles of industrial safety and occupational health. 1.2 Describe workplace hazards in wood and paper industries. 1.3 Explain causes and effects of workplace accidents. 1.4 Explain occupational health hazards associated with wood dust, chemicals, noise and machine operations. 1.5 Explain safety signs	•Discuss principles of industrial safety and occupational health. •Explain workplace hazards in wood and paper industries. •Discuss causes and effects of workplace accidents. •Discuss occupational health hazards associated with wood dust, chemicals, noise and machine operations.	occupational-safety legislation, safety manuals, hazard charts, risk-assessment templates, case studies, computer, projector, internet resources.	• Identify workplace hazards from workshop/sawmill settings. • Interpret industrial safety signs and symbols. • Prepare workplace hazard checklist for wood workshop. • Demonstrate or model principles of industrial safety and occupational health through an assigned practical exercise.	Guide students to: • Identify workplace hazards from workshop/sawmill settings. • Interpret industrial safety signs and symbols. • Prepare workplace hazard checklist for wood workshop. • Demonstrate or model principles of industrial safety and occupational	PPE, fire extinguishers, first-aid kit, hazard labels, risk-assessment forms, emergency checklist.

	and regulations in industrial environments.	• Discuss safety signs and regulations in industrial environments.			health through an assigned practical exercise.	
General Objective 2.0: : Know workshop and machine safety practices						
4–7	2.1 Explain workshop safety rules and regulations. 2.2 Explain machine safety requirements in wood industries. 2.3 Explain personal protective equipment (PPE) and their uses. 2.4 Explain safe handling of chemicals and hazardous materials.	• Discuss workshop safety rules and regulations using relevant examples, diagrams and illustrations. • Discuss machine safety requirements in wood industries using relevant examples, diagrams and illustrations. • Discuss personal protective equipment (PPE) and their uses using relevant examples, diagrams and illustrations. • Discuss safe handling of chemicals and hazardous materials using relevant examples, diagrams and illustrations.	occupational-safety legislation, safety manuals, hazard charts, risk-assessment templates, case studies, computer, projector, internet resources.	• Use PPE correctly. • Conduct workshop safety inspection using checklist. • Demonstrate safe machine handling procedures. • Demonstrate or model workshop safety rules and regulations through an assigned practical exercise.	Guide students to: • Use PPE correctly. • Conduct workshop safety inspection using checklist. • Demonstrate safe machine handling procedures. • Demonstrate or model workshop safety rules and regulations through an assigned practical exercise.	PPE, fire extinguishers, first-aid kit, hazard labels, risk-assessment forms, emergency checklist.

General Objective 3.0: Know accident prevention, emergency response and fire safety						
8-11	3.1 Explain causes and prevention of industrial accidents. 3.2 Describe emergency response procedures in industrial settings. 3.3 Describe fire hazards and fire prevention methods. 3.4 Describe accident reporting procedures and first aid principles.	• Discuss causes and prevention of industrial accidents using relevant examples, diagrams and illustrations. • Discuss emergency response procedures in industrial settings using relevant examples, diagrams and illustrations. • Discuss fire hazards and fire prevention methods using relevant examples, diagrams and illustrations. • Explain accident reporting procedures and first aid principles using relevant examples, diagrams and illustrations.	occupational-safety legislation, safety manuals, hazard charts, risk-assessment templates, case studies, computer, projector, internet resources.	• Demonstrate use of fire extinguisher. • Conduct emergency evacuation drill. • Simulate workplace accident reporting exercise. • Demonstrate basic first aid procedures.	Guide students to: • Demonstrate use of fire extinguisher. • Conduct emergency evacuation drill. • Simulate workplace accident reporting exercise. • Demonstrate basic first aid procedures.	PPE, fire extinguishers, first-aid kit, hazard labels, risk-assessment forms, emergency checklist.
General Objective 4.0: Understand environmental management practices in wood and paper industries;						
12-15	4.1 Explain environmental issues associated	• Discuss environmental issues associated with wood	occupational-safety legislation,	• Identify environmental hazards in workshop/sawmill	Guide students to: • Identify environmental	PPE, fire extinguishers, first-aid kit,

	with wood and paper industries. 4.2 Explain wood waste management practices. 4.3 Explain pollution prevention and control measures. 4.4 Explain environmental sustainability and regulatory compliance. 4.5 Explain emerging trends in industrial safety and environmental management.	and paper industries using relevant examples, diagrams and illustrations. • Discuss wood waste management practices using relevant examples, diagrams and illustrations. • Discuss pollution prevention and control measures using relevant examples, diagrams and illustrations. • Discuss environmental sustainability and regulatory compliance using relevant examples, diagrams and illustrations. • Discuss emerging trends in industrial safety and environmental management using relevant examples, diagrams and illustrations.	safety manuals, hazard charts, risk-assessment templates, case studies, computer, projector, internet resources.	settings. • Conduct environmental audit using checklist. • Classify wood waste for recycling or reuse. • Demonstrate or model environmental issues associated with wood and paper industries through an assigned practical exercise.	hazards in workshop/sawmill settings. • Conduct environmental audit using checklist. • Classify wood waste for recycling or reuse.,. • Demonstrate or model environmental issues associated with wood and paper industries through an assigned practical exercise.	hazard labels, risk-assessment forms, emergency checklist.
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COURSE ASSESSMENT

Coursework:	10%
Tests:	10%
Practical:	40%
Examination:	40%
Total:	100%



CLIMATE CHANGE AND FOREST RESOURCES.

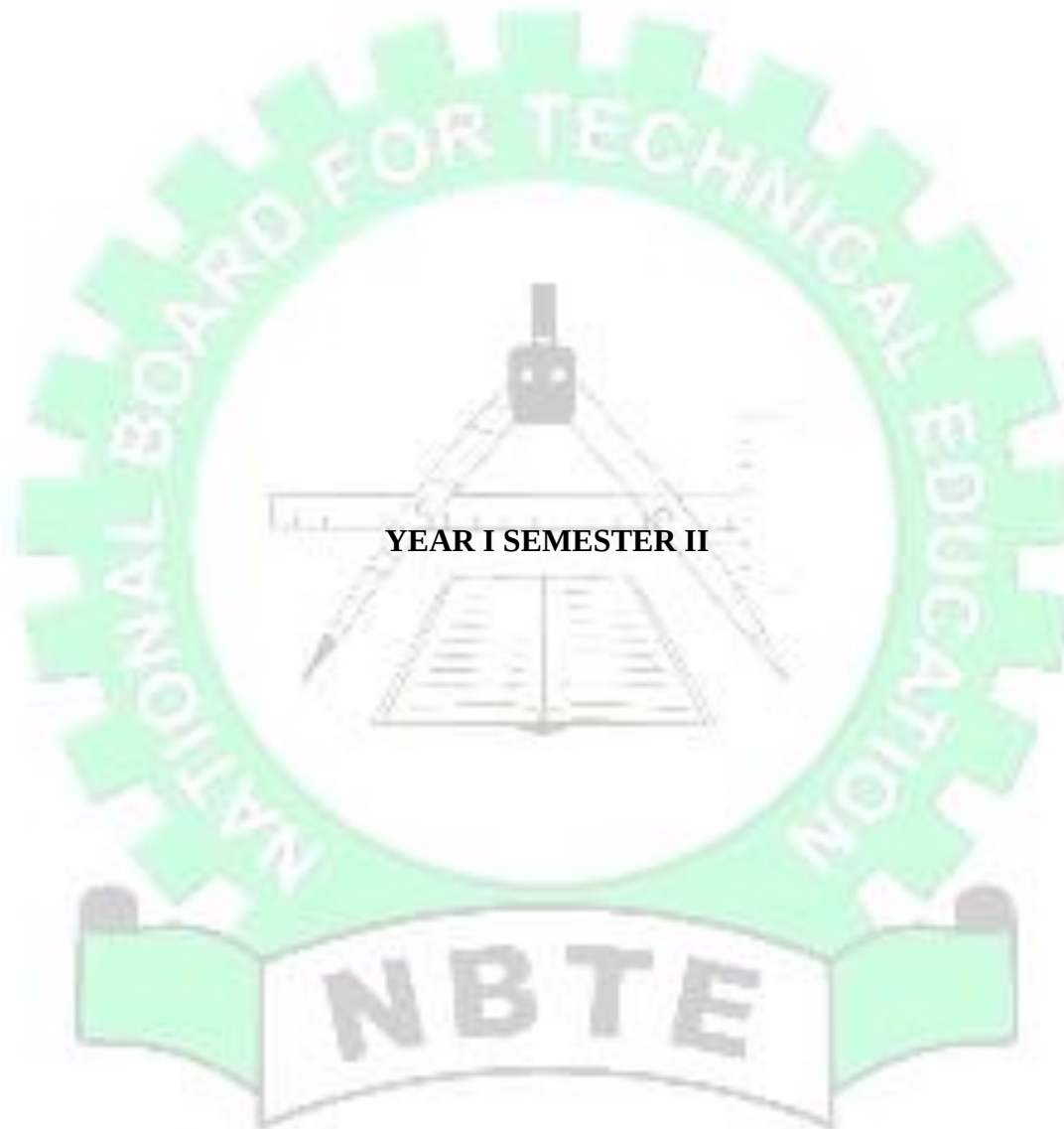
PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)		
COURSE TITLE: CLIMATE CHANGE AND FOREST RESOURCES.	COURSE CODE: WPT 318	CONTACT HOURS: 2 HOURS/WEEK
	CREDIT UNIT: 2	THEORETICAL: 1 HOUR/WEEK
YEAR: HND 1 SEMESTER: I	PRE-REQUISITE: NIL	PRACTICAL: 1 HOUR/WEEK
GOAL: This course is designed to provide students with comprehensive knowledge and practical skills on climate change, forest ecosystem, sustainable forest resource management, environmental conservation, carbon sequestration and climate adaption strategies.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the concept, causes and effects of climate change and global warming. 2.0 Know the relationship between forests, biodiversity, and climate regulation 3.0 Understand deforestation, forest degradation, and sustainable forest management practices. 4.0 Understand carbon sequestration, climate mitigation, and adaptation strategies in forestry.		

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)						
COURSE TITLE: CLIMATE CHANGE AND FOREST RESOURCES.		COURSE CODE: WPT 318		CONTACT HOURS: 2 HOURS/WEEK		
		CREDIT UNIT: 2		THEORETICAL: 1 HOUR/WEEK		
YEAR: I SEMESTER: I		PRE-REQUISITE: NIL		PRACTICAL: 1 HOUR/WEEK		
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with comprehensive knowledge and practical skills on climate change, forest ecosystem, sustainable forest resource management, environmental conservation, carbon sequestration and climate adaption strategies.						
GENERAL OBJECTIVE 1.0: Understand the concept, causes and effects of climate change and global warming.						
THEORETICAL				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1-3	1.1 Explain climate change and global warming. 1.2 Describe causes of climate change. 1.3 Explain effects of climate change on forests. 1.4 Explain impacts on forestry and wood industries.	•Discuss climate change and global warming. •Explain causes of climate change •Discuss effects of climate change on forests. •Discuss impacts on forestry and wood industries.	climate-change reports, climate datasets, forest maps, GIS illustrations, case studies, computer, projector, internet resources.	• Observe environmental indicators of climate change. • Demonstrate or model climate change and global warming through an assigned practical exercise. • Identify causes of climate change using the specified criteria. • Conduct a practical investigation of effects of climate change on forests • Interpret the	Guide students to: • Observe environmental indicators of climate change. • Demonstrate or model climate change and global warming through an assigned practical exercise. • Identify causes of climate change using the	Computer, climate datasets, maps, GIS software, carbon calculator, field sheets, GPS device.

				observed results.	specified criteria. • Conduct a practical investigation of effects of climate change on forests	
General Objective 2.0: Know the relationship between forests, biodiversity, and climate regulation.						
4-7	2.1 Explain forest ecosystem functions. 2.2 Describe species diversity and conservation methods. 2.3 Explain the role of forests in climate regulation. 2.4 Describe rainfall and temperature regulation.	• Discuss forest ecosystem functions. • Discuss species diversity and conservation methods. • Describe the role of forests in climate regulation • Discuss rainfall and temperature regulation using relevant	climate-change reports, climate datasets, forest maps, GIS illustrations, case studies, computer, projector, internet resources.	• Demonstrate or model forest ecosystem functions through an assigned practical exercise. • Demonstrate or model species diversity and conservation methods through an assigned practical exercise. • Demonstrate or model the role of forests in climate regulation through an assigned practical exercise.	Guide students to: • Demonstrate or model forest ecosystem functions through an assigned practical exercise. • Demonstrate or model species diversity and conservation methods through an assigned practical exercise. • Demonstrate or model the role of forests in climate regulation through an assigned practical exercise.	Computer, climate datasets, maps, GIS software, carbon calculator, field sheets, GPS device.
General Objective 3.0: Understand deforestation, forest degradation, and sustainable forest management practices.						

8-11	3.1 Explain causes of deforestation. 3.2 Describe effects of forest degradation. 3.3 Explain environmental and economic impacts of deforestation. 3.4 Describe sustainable forest management. 3.5 Explain forest policies and regulation.	• Discuss causes of deforestation. • Explain effects of forest degradation • Discuss environmental and economic impacts of deforestation • Discuss sustainable forest management • Discuss forest policies and regulation	climate-change reports, climate datasets, forest maps, GIS illustrations, case studies, computer, projector, internet resources.	• Demonstrate or model causes of deforestation through an assigned practical exercise. • Conduct a practical investigation of effects of forest degradation and interpret the observed results. • Demonstrate or model environmental and economic impacts of deforestation through an assigned practical exercise.	Guide students to: • Demonstrate or model causes of deforestation through an assigned practical exercise. • Conduct a practical investigation of effects of forest degradation and interpret the observed results. • Demonstrate or model environmental and economic impacts of deforestation through an assigned practical exercise.	Computer, climate datasets, maps, GIS software, carbon calculator, field sheets, GPS device.
General Objective 4.0: Comprehend carbon sequestration, climate mitigation, and adaptation strategies in forestry.						
12-15	4.1 Describe carbon cycle and sequestration. 4.2 Explain climate mitigation strategies. 4.3 Explain adaptation	• Explain carbon cycle and sequestration with relevant examples, diagrams or case materials. • Discuss climate mitigation strategies.	climate-change reports, climate datasets, forest maps, GIS	• Observe carbon cycle and sequestration using the specified criteria. • Identify carbon cycle and sequestration using the specified criteria. • Document carbon cycle	Guide students to: • Observe carbon cycle and sequestration using the specified criteria.	Computer, climate datasets, maps, GIS software, carbon calculator, field sheets, GPS device.

	strategies. 4.4 Describe renewable forest resources.	• Discuss adaptation strategies. • Explain renewable forest resources with relevant examples, diagrams or case materials.	illustrations, case studies, computer, projector, internet resources.	and sequestration using the specified criteria. • Demonstrate or model climate mitigation strategies through an assigned practical exercise. • Document renewable forest resources using the specified criteria.	• Identify carbon cycle and sequestration using the specified criteria. • Document carbon cycle and sequestration using the specified criteria. • Demonstrate or model climate mitigation strategies through an assigned practical exercise. • Document renewable forest resources using the specified criteria.	
COURSE ASSESSMENT Coursework: 10% Tests: 10% Practical: 40% Examination: 40% Total: 100%						



ENVIRONMENTAL IMPACT ASSESSMENT IN WOOD PRODUCTION

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)		
COURSE TITLE: ENVIRONMENTAL IMPACT ASSESSMENT IN WOOD PRODUCTION	COURSE CODE: WPT 321	CONTACT HOURS: 2 HOURS/WEEK
	CREDIT UNIT: 2	THEORETICAL: 1 HOUR/WEEK
YEAR: HND 1 SEMESTER: II	PRE-REQUISITE: NIL	PRACTICAL: 1 HOUR/WEEK
GOAL: The course is designed to equip students with knowledge and skills required to assess, evaluate, and manage environmental impacts associated with wood and paper industries.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the concept and principles of Environmental Impact Assessment (EIA). 2.0 Understand environmental impacts and pollution associated with wood and paper industries. 3.0 Know the methods and procedures used in conducting Environmental Impact Assessment. 4.0 Understand environmental laws, regulations, and mitigation measures in wood industries. 5.0 Understand sustainable forest resource management and climate protection strategies.		

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)						
COURSE TITLE: ENVIRONMENTAL IMPACT ASSESSMENT IN WOOD PRODUCTION:		COURSE CODE: WPT 321		CONTACT HOURS: 2 HOURS/WEEK		
		CREDIT UNIT: 2		THEORETICAL: 1 HOUR/WEEK		
YEAR: I SEMESTER: II		PRE-REQUISITE: NIL		PRACTICAL: 1 HOUR/WEEK		
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills required to assess, evaluate, and manage environmental impacts associated with wood and paper industries.						
GENERAL OBJECTIVE 1.0: Understand the concept and principles of Environmental Impact Assessment (EIA).						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1-3	1.1 Explain Environmental Impact Assessment (EIA). 1.2 Outline the objectives of EIA. 1.3 Explain principles of EIA. 1.4 Describe stages involved in EIA. 1.5 Explain benefits of EIA.	• Discuss environmental Impact Assessment. • Explain the objectives of EIA with relevant examples • Discuss principles of EIA. • Explain stages involved in EIA with relevant examples. • Discuss benefits of	EIA guidelines, environmental regulations, impact checklists, case studies, process-flow diagrams, computer, projector, internet resources.	• Demonstrate environmental Impact Assessment. • Prepare a concise illustrated summary of the objectives of EIA. • Demonstrate principles of EIA. • Analyse an assigned practical case on Environmental	Guide students to: • Demonstrate environmental Impact Assessment. • Prepare a concise illustrated summary of the objectives of EIA. • Demonstrate principles of EIA. • Analyse an assigned practical case on Environmental	EIA checklist sampling containers field meters GPS device camera maps data sheets PPE.

		EIA using relevant examples.		Impact Assessment. • Analyse an assigned practical case on the objectives of EIA. • Analyse an assigned practical case on principles of EIA.	Impact Assessment. • Analyse an assigned practical case on the objectives of EIA. • Analyse an assigned practical case on principles of EIA.	
General Objective 2.0: Understand environmental impacts and pollution associated with wood and paper industries.						
4-6	2.1 Describe sources of pollution in wood industries. 2.2 Explain effects of industrial pollution. 2.3 Explain air, water, noise and soil pollution in wood industries. 2.4 Describe causes of deforestation and land degradation. 2.5 Explain wood waste management practices.	• Explain sources of pollution in wood industries. • Discuss effects of industrial pollution. • Discuss air, water, noise and soil pollution in wood industries. • Explain causes of deforestation and land degradation. • Discuss wood waste management practices.	EIA guidelines, environmental regulations, impact checklists, case studies, process-flow diagrams, computer, projector, internet resources.	• Identify pollutants in wood workshop. • Classify wood waste materials. • Visit wood waste dump sites. • Demonstrate waste segregation techniques. • Demonstrate sources of pollution in wood industries. • Classify sources of pollution in wood industries using selected samples.	Guide students to: • Identify pollutants in wood workshop. • Classify wood waste materials. • Visit wood waste dump sites. • Demonstrate waste segregation techniques. • Demonstrate sources of pollution in wood industries. • Classify sources of pollution in wood industries using selected	EIA checklist sampling containers field meters GPS device camera maps data sheets PPE.

					samples.	
General Objective 3.0: Know methods and procedures used in conducting Environmental Impact Assessment.						
7-10	3.1 Describe procedures used in EIA. 3.2 Explain environmental data collection methods. 3.3 Describe environmental sampling techniques. 3.4 Describe methods of environmental analysis. 3.5 Explain environmental reporting methods.	• Discuss procedures used in EIA. • Discuss environmental data collection methods. • Explain environmental sampling techniques. • Explain methods of environmental analysis. • Discuss environmental reporting methods using relevant examples, diagrams and illustrations.	EIA guidelines, environmental regulations, impact checklists, case studies, process-flow diagrams, computer, projector, internet resources.	• Demonstrate procedures used in EIA. • Demonstrate environmental data collection methods using relevant software. • Present the output. • Document environmental sampling techniques. • Analyse an assigned practical case on procedures used in EIA. • Analyse an assigned practical case on environmental sampling techniques.	Guide students to: • Demonstrate procedures used in EIA. • Demonstrate environmental data collection methods using relevant software. • Present the output. • Document environmental sampling techniques. • Analyse an assigned practical case on procedures and environmental sampling technique used in EIA.	EIA checklist sampling containers field meters GPS device camera maps data sheets PPE.
General Objective 4.0: Understand environmental laws, regulations, and mitigation measures in wood industries.						

11-12	4.1 Outline the environmental laws and regulations. 4.2 Explain environmental compliance procedures. 4.3 Describe pollution control measures. 4.4 Explain mitigation measures for environmental degradation. 4.5 Explain waste minimization techniques.	• Explain the environmental laws and regulations. • Discuss environmental compliance procedures. • Explain pollution control measures. • Discuss mitigation measures for environmental degradation using relevant examples, diagrams and illustrations. • Discuss waste minimization techniques using relevant examples, diagrams and illustrations.	EIA guidelines, environmental regulations, impact checklists, case studies, process-flow diagrams, computer, projector, internet resources.	• Prepare a concise illustrated summary of the environmental laws and regulations. • Demonstrate environmental compliance procedures. • Document pollution control measures. • Analyse an assigned practical case on the environmental laws and regulations. • Apply environmental compliance procedures to an assigned practical case. • Use relevant software for pollution control measures.	Guide students to: • Prepare a concise illustrated summary of the environmental laws and regulations. • Demonstrate environmental compliance procedures. • Document pollution control measures. • Analyse an assigned practical case on the environmental laws and regulations. • Apply environmental compliance procedures to an assigned practical case. • Use relevant software for pollution control measures.	EIA checklist sampling containers field meters GPS device camera maps data sheets PPE.
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General Objective 5.0: Understand sustainable forest resource management and climate protection strategies.						
13-15	5.1 Describe sustainable forest management. 5.2 Outline the causes of climate change. 5.3 Describe effects of climate change on forest resources. 5.4 Describe climate change mitigation measures. 5.5 Explain importance of environmental sustainability.	• Explain sustainable forest management. • Explain the causes of climate change. • Explain effects of climate change on forest resources. • Explain climate change mitigation measures. • Discuss importance of environmental sustainability	EIA guidelines, environmental regulations, impact checklists, case studies, process-flow diagrams, computer, projector, internet resources.	• Document sustainable forest management. • Document effects of climate change on forest resources. • Prepare sustainable forest management for an assigned industry task. • Assess the causes of climate change through a field or laboratory exercise. • Analyse an assigned case on importance of environmental sustainability.	Guide students to: • Document sustainable forest management. • Document effects of climate change on forest resources. • Prepare sustainable forest management for an assigned industry task. • Assess the causes of climate change through a field or laboratory exercise. • Analyse an assigned case on importance of environmental sustainability.	EIA checklist sampling containers field meters GPS device camera maps data sheets PPE.
COURSE ASSESSMENT Coursework: 10% Tests: 10% Practical: 40% Examination: 40% Total: 100%						

SAWMILLING AND TIMBER PROCESSING TECHNOLOGY

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND WOOD PROCESSING TECHNOLOGY		
COURSE TITLE: SAWMILLING AND TIMBER PROCESSING TECHNOLOGY	COURSE CODE: WPT 322	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: HND I SEMESTER: II	PRE-REQUISITE:	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills in sawmilling operations.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand sawmilling systems and operations 2.0 Know timber conversion and processing techniques 3.0 Understand sawmill machine operations, maintenance and safety practices; 4.0 Understand the various sawmilling techniques and sawmill products 5.0 Understand the activities of the ply milling industry 6.0 Understand the processes and techniques involved in the manufacture of particle board 7.0 Understand the processes and techniques involved in the manufacture of fibreboard 8.0 Know the types and uses of wood veneer and modern wood products 9.0 Know industrial sawmilling and timber processing practices.		

PROGRAMME: NATIONAL HIGHER DIPLOMA WOOD AND WOOD PROCESSING TECHNOLOGY						
COURSE TITLE: SAWMILLING AND TIMBER PROCESSING TECHNOLOGY		COURSE CODE: WPT 322		CONTACT HOURS: 4 HOURS/WEEK		
		CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK		
YEAR: I SEMESTER: II		PRE-REQUISITE: NIL		PRACTICAL: 3 HOURS/WEEK		
COURSE SPECIFICATION: THEORETICAL AND PRACTICA						
GOAL: This course is designed to equip students with advanced practical competencies in sawmilling operations.						
GENERAL OBJECTIVE 1.0:Understand sawmilling systems and operations;						
THEORETICAL:				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1	1.1 Explain sawmilling systems and industrial workflow. 1.2 Describe types of sawmills and processing layouts. 1.3 Describe sawmilling equipment and machine functions. 1.4 Explain factors affecting sawmill productivity and efficiency. 1.5 Outline industrial safety requirements in sawmilling operations.	• Discuss sawmilling systems and industrial workflow. • Explain types of sawmills and processing layouts. • Explain sawmilling equipment and machine functions • Discuss factors affecting sawmill productivity and efficiency. • Discuss industrial safety requirements in sawmilling operations	sawmilling manuals, machine diagrams, conversion charts, maintenance manuals, safety standards, computer, projector, internet resources.	• Identify sawmill machines and their functions. • Draw sawmill process flow diagram. • Observe sawmill operational sequence through field visit/video demonstration. • Record sawmill operational sequence through field visit/video • Prepare sawmill operation checklist.	Guide students to: • Identify sawmill machines and their functions. • Draw sawmill process flow diagram. • Observe sawmill operational sequence through field visit/video demonstration. • Record sawmill operational sequence through field visit/video	timber blocks, sawmill machines or models, measuring tools, maintenance checklist, calculator, practical manual, PPE.

					• Prepare sawmill operation checklist.	
General Objective 2.0: Know timber conversion and processing techniques.						
2	2.1 Describe the external features of the sawmill log. 2.2 Explain the function of the various parts of sawmill 2.3 Describe timber conversion methods and sawing patterns. 2.4 Explain log breakdown and cutting optimization techniques. 2.5 Describe timber sizing and dimensional accuracy. 2.6 Explain causes of timber processing defects.	• Explain the external features of the sawmill log. • Discuss the function of the various parts of sawmill log. • Explain timber conversion methods and sawing patterns • Discuss log breakdown and cutting optimization techniques • Discuss timber sizing and dimensional accuracy • Discuss causes of timber processing defects	sawmilling manuals, machine diagrams, conversion charts, maintenance manuals, safety standards, computer, projector, internet resources.	• Measure logs and estimate timber volume. • Select appropriate sawing pattern for selected log sizes., • Carry out timber cutting and sizing exercises. • Assess dimensional accuracy of processed timber. • Identify defects arising during timber conversion.	Guide students to: • Measure logs and estimate timber volume. • Select appropriate sawing pattern for selected log sizes., • Carry out timber cutting and sizing exercises. • Assess dimensional accuracy of processed timber. • Identify defects arising during timber conversion.	timber blocks, sawmill machines or models, measuring tools, maintenance checklist, calculator, practical manual, PPE.
General Objective 3.0: Understand sawmill machine operations, maintenance and safety practices						
3	3.1 Explain principles of sawmill machine operation. 3.2 Describe preventive	• Discuss principles of sawmill machine operation. • Explain preventive	sawmilling manuals, machine diagrams,	• Demonstrate safe operation of selected sawmill machines. • Conduct routine	Guide students to: • Demonstrate safe operation of	timber blocks, sawmill machines or models,

	maintenance procedures. 3.3 Describe machine troubleshooting techniques. 3.4 Explain workshop and sawmill safety requirements.	maintenance procedures. • Explain machine troubleshooting techniques • Discuss workshop and sawmill safety requirements	conversion charts, maintenance manuals, safety standards, computer, projector, internet resources.	machine inspection and maintenance exercise. • Identify common machine faults and corrective actions. • Conduct sawmill safety inspection using checklist.	selected sawmill machines. • Conduct routine machine inspection and maintenance exercise. • Identify common machine faults and corrective actions. • Conduct sawmill safety inspection using checklist.	measuring tools, maintenance checklist, calculator, practical manual, PPE.
General Objective 4.0: Understand the various sawmilling techniques and sawmill products						
4	4.1 Describe the factors governing the choice of a log for sawmilling. 4.2 Explain the various techniques for log handling 4.3 Describe the various sawmilling techniques Explain integrated sawmilling. 4.4 Describe the principles of waste control in sawmills	• Explain the factors governing the choice of a log for sawmilling • Discuss the various techniques for log handling (Mine detection, transportation and storage) • Explain the various sawmilling techniques • Discuss integrated sawmilling. • Explain the principles	sawmilling manuals, machine diagrams, conversion charts, maintenance manuals, safety standards, computer, projector, internet resources.	• Design an ideal sawmills site and layout. • Perform the various techniques for log handling (Mine detection, transportation and storage). • Perform the various sawmilling techniques (quarter-sawing, plain-sawing, live sawing and taper sawing).	• Design an ideal sawmills site and layout. • Perform the various techniques for log handling (Mine detection, transportation and storage). • Perform the various sawmilling techniques	timber blocks, sawmill machines or models, measuring tools, maintenance checklist, calculator, practical manual, PPE.

	4.5 Outline the problems of the sawmill industry and their possible solutions. 4.6 Describe the types of sawn wood and their uses. 4.7 State the advantages and disadvantages of sawn wood over wood based panel products	of waste control in sawmills • Highlight the problems of the sawmill industry and their possible solutions. • Discuss the advantages and disadvantages of sawn wood over wood based panel products		• Identify the commercial sizes of sawn wood.	(quarter-sawing, plain-sawing, live sawing and taper sawing). • Identify the commercial sizes of sawn wood.	
General Objective 5.0: Understand the activities of the ply milling industry						
5-6	5.1 Describe the various steps in the manufacture of veneer. 5.2 Describe the two main methods of cutting decorative veneer. 5.3 Describe the uses of decorative veneers and non-peeled veneers.	• Explain the various steps in the manufacture of veneer. • Explain the two main methods of cutting decorative veneer. • Explain the uses of decorative veneers and non-peeled veneers with relevant examples, diagrams or case materials.	sawmilling manuals, machine diagrams, conversion charts, maintenance manuals, safety standards, computer, projector, internet resources.	• Perform the various steps in the manufacture of veneer: Log preparation - peeling/patching/clipping - peeling/slicing/sawing - drying - sorting/grading and repair of veneer. • Perform the two main methods of cutting decorative veneer: Slicing - semi - rotary cutting. • Perform the uses of	• Perform the various steps in the manufacture of veneer: Log preparation - peeling/patching/clipping - peeling/slicing/sawing - drying - sorting/grading and repair of veneer. • Perform the two main methods of cutting decorative veneer: Slicing -	timber blocks, sawmill machines or models, measuring tools, maintenance checklist, calculator, practical manual, PPE.

				decorative veneers and non-peeled veneers.	semi - rotary cutting. • Perform the uses of decorative veneers and non-peeled veneers.	
General Objective 6.0: Understand the techniques involved in the manufacture of particle board						
7-8	6.1 Explain the production sequence of particle board. 6.2 Describe resin blending, particle classification, mat formation and preparation for pressing. 6.3 Describe flat-pressing and extrusion methods 6.4 Explain board finishing, laminating and moulding operations. 6.5 State factors affecting particleboard properties.	• Explain the production sequence of particle board. • Describe resin blending, particle classification, mat formation and preparation for pressing. • Describe flat-pressing and extrusion methods • Explain board finishing, laminating and moulding operations. • State factors affecting particleboard properties.	sawmilling manuals, machine diagrams, conversion charts, maintenance manuals, safety standards, computer, projector, internet resources.	• Draw a process flow chart for the manufacture of particle board. • Produce particle board using the various tools and equipment and applying any of the techniques already described. • Determine the density, weight per unit area, moisture content, moisture absorption and swelling of particle board. • Determine the bending strength, impact strength, compressive strength, shear strength, hardness, and screw/nail holding capacity of particle	Guide students to: • Draw a process flow chart for the manufacture of particle board. • Produce particle board using the various tools and equipment and applying any of the techniques already described. • Determine the density, weight per unit area, moisture content, moisture absorption and swelling of particle board. • Determine the	timber blocks, sawmill machines or models, measuring tools, maintenance checklist, calculator, practical manual, PPE.

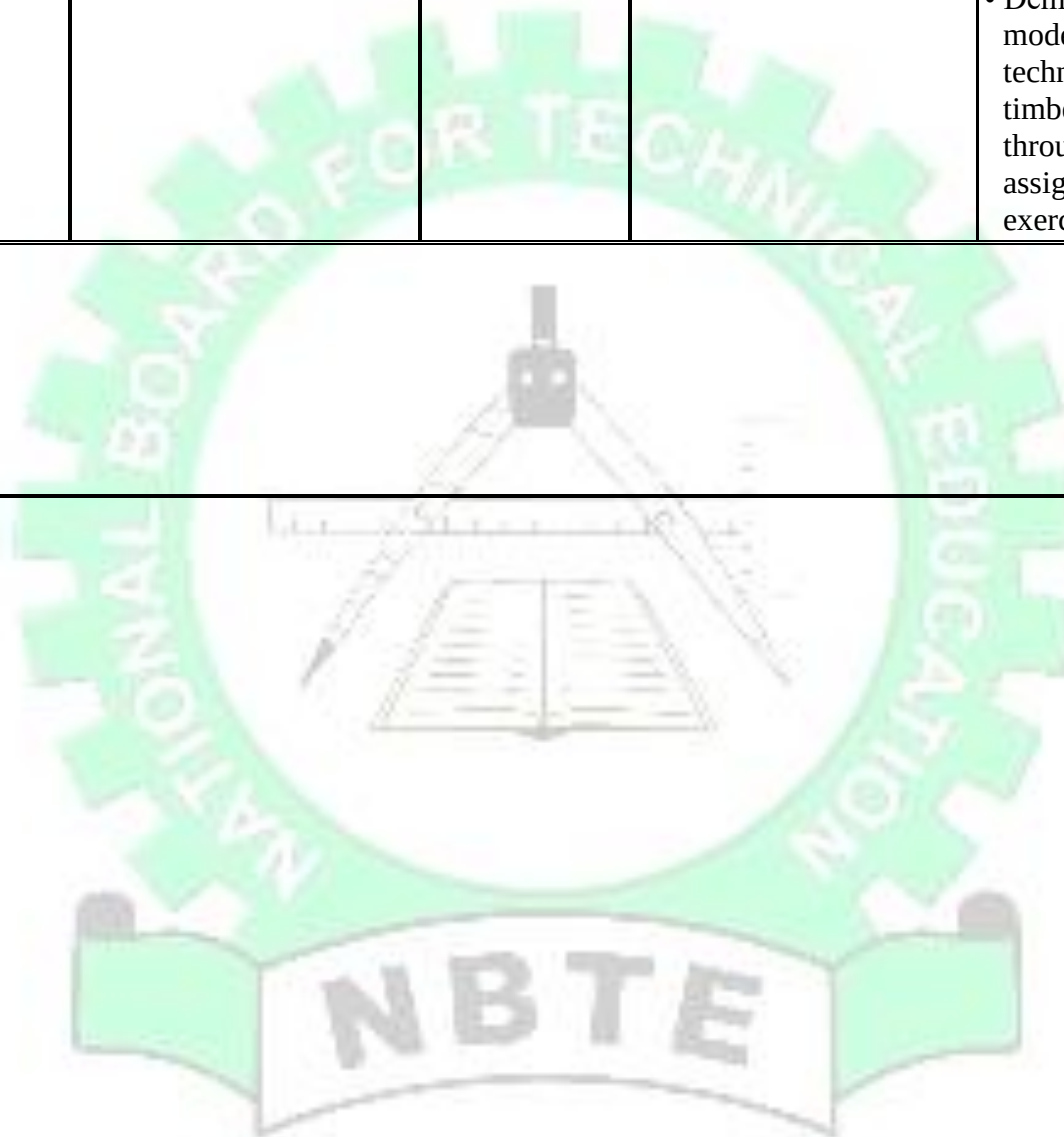
				board.	bending strength, impact strength, compressive strength, shear strength, hardness, and screw/nail holding capacity of particle board.	
General Objective 7.0 Understand the techniques involved in the manufacture of fibre board						
9-10	7.1 Outline market demand, prospects and commercial grades of fibreboard. 7.2 Describe fibreboard raw materials and the operations used for debarking, chipping, screening and conditioning. 7.3 Describe differences between mechanical, chemical, explosion and Asplund fibre-preparation processes. 7.4 Explain stock sizing, mat formation, wet. 7.5 Explain processes, and wet- and air-felting methods.	• Highlight the development, uses, market demand, prospects and commercial grades of fibreboard. • Explain fibreboard raw materials and the operations used for debarking, chipping, screening and conditioning. • Discuss differences between mechanical, chemical, explosion and Asplund fibre-preparation processes. • Describe stock sizing, mat formation, wet. • Explain processes, and wet- and air-felting	sawmilling manuals, machine diagrams, conversion charts, maintenance manuals, safety standards, computer, projector, internet resources.	• Analyse the available consumption rate of fibre board. • Compare its rate of consumption to those of particle board and plywood. • Assess the prospects of the product in Nigeria in terms of its uses, rate of consumption and the expected standard of living. • Produce fibre boards using various tools and equipment and applying any of the methods already described. • Determine the density,	• Analyse the available consumption rate of fibre board. • Compare its rate of consumption to those of particle board and plywood. • Assess the prospects of the product in Nigeria in terms of its uses, rate of consumption and the expected standard of living. • Produce fibre boards using	timber blocks, sawmill machines or models, measuring tools, maintenance checklist, calculator, practical manual, PPE.

		methods.		weight per unit area, moisture content, moisture absorption and swelling of fibre board. • Determine the bending strength, impact strength, tensile strength, compressive strength, shear strength, hardness, screw/nail holding capacity of fibre board. • Record explain grades of fibre boards in the market.	various tools and equipment and applying any of the methods already described. • Determine the density, weight per unit area, moisture content, moisture absorption and swelling of fibre board. • Determine the bending strength, impact strength, tensile strength, compressive strength, shear strength, hardness, screw/nail holding capacity of fibre board. • Record explain grades of fibre boards in the market.	
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General Objective 8.0 Know the types and uses of wood veneer and modern wood products						
11 -12	8.1 Describe plywood manufacturing processes and grades. 8.2 Describe the use of different types of plywood. 8.3 Explain the principles of dimensional stabilisation of wood. 8.4 Describe dimensional-stabilisation products and their uses.	• Explain plywood manufacturing processes and grades. • Describe the use of different types of plywood. • Discuss the principles of dimensional stabilisation of wood. • Explain dimensional-stabilisation products and their uses.	sawmilling manuals, machine diagrams, conversion charts, maintenance manuals, safety standards, computer, projector, internet resources.	• Perform the manufacturing processes of plywood starting from the wood veneer to the plywood. • Prepare a concise illustrated summary of plywood. • Compare the various uses of the different types of plywood e.g. in building and furniture manufacture using specified criteria. • Present the results in a table or chart. • Demonstrate dimensional Stabilization of wood with examples. • Analyse an assigned practical case on plywood manufacturing processes and grades.	• Perform the manufacturing processes of plywood starting from the wood veneer to the plywood. • Prepare a concise illustrated summary of plywood. • Compare the various uses of the different types of plywood e.g. in building and furniture manufacture using specified criteria. • Present the results in a table or chart. • Demonstrate dimensional Stabilization of wood with	timber blocks, sawmill machines or models, measuring tools, maintenance checklist, calculator, practical manual, PPE.

					examples. • Analyse an assigned practical case on plywood manufacturing processes and grades.	
General Objective 9.0: Know industrial sawmilling and timber processing practices						
13–15	9.1 Explain industrial sawmill management systems. 9.2 Describe quality assurance practices in sawmills. 9.3 Outline emerging technologies in timber processing. 9.4 Explain industrial supervision practices in timber processing operations.	• Discuss industrial sawmill management systems. • Discuss quality assurance practices in sawmills. • Highlight emerging technologies in timber processing. • Discuss industrial supervision practices in timber processing operations using relevant examples, diagrams and illustrations.	sawmilling manuals, machine diagrams, conversion charts, maintenance manuals, safety standards, computer, projector, internet resources.	• Visit sawmill or timber processing facility and assess workflow, productivity and quality systems. • Demonstrate or model industrial sawmill management systems through an assigned practical exercise. • Demonstrate or model quality assurance practices in sawmills through an assigned practical exercise. • Demonstrate or model emerging technologies in timber processing through an assigned practical exercise.	Guide students to: • Visit sawmill or timber processing facility and assess workflow, productivity and quality systems. • Demonstrate or model industrial sawmill management systems through an assigned practical exercise. • Demonstrate or model quality assurance practices in sawmills through an assigned practical exercise.	timber blocks, sawmill machines or models, measuring tools, maintenance checklist, calculator, practical manual, PPE.

					• Demonstrate or model emerging technologies in timber processing through an assigned practical exercise.	
COURSE ASSESSMENT Coursework: 10% Tests: 10% Practical: 40% Examination: 40% Total: 100%						



FOREST OPERATIONS AND TECHNIQUES

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)		
COURSE TITLE: FOREST OPERATIONS AND TECHNIQUES	COURSE CODE: WPT 323	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: II	PRE-REQUISITE: WPT 214	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is equipped to provide students with knowledge and skills in forest road, culvert and camps construction, timber and pulpwood harvesting systems.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the planning, design, and construction of forest roads, culverts, and camps. 2.0 Know the process of obtaining forest concessions in Nigeria. 3.0 Understand the techniques of timber and pulpwood harvesting 4.0 Understand skidding as an essential operation in the harvesting system. 5.0 Understand the principles and techniques of loading and unloading harvested products. 6.0 Understand the major methods of transporting harvested products to the mill. 7.0 Understand the need for proper timber production management and sustainable forest harvesting practices.		

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)						
COURSE TITLE: FOREST OPERATIONS AND TECHNIQUES		COURSE CODE: WPT 323		CONTACT HOURS: 4 HOURS/WEEK		
		CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK		
YEAR: I SEMESTER: II		PRE-REQUISITE: NIL		PRACTICAL: 3 HOURS/WEEK		
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is equipped to provide students with knowledge and skills in forest road, culvert and camps construction, timber and pulpwood harvesting systems.						
GENERAL OBJECTIVE 1.0: Understand the planning, design, and construction of forest roads, culverts, and camps						
Week	THEORETICAL			PRACTICAL CONTENT		
	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-2	1.1 Explain the key stages of planning for forest road construction. 1.2 Describe the preliminary preparations required for forest road construction. 1.3 Explain the principles of forest road construction. 1.4 Describe the process of culvert planning, design, and construction 1.5 State the materials	•Explain the key stages of planning for forest road construction. •Describe the preliminary preparations required for forest road construction. •Explain the principles of forest road construction. •Describe the process of culvert planning, design, and construction •State the materials and	forest-operation manuals, topographic maps, engineering drawings, equipment charts, safety codes, computer, projector, internet resources.	• Perform reading and interpretation of topographic and forest road maps. • Visit a forest road construction or maintenance site • Observe earthwork and drainage features. • Sketch an existing forest bridge or culvert. • Identify materials and structural components.	• Perform reading and interpretation of topographic and forest road maps. • Visit a forest road construction or maintenance site • Observe earthwork and drainage features. • Sketch an existing forest bridge or culvert. • Identify materials and structural components.	Surveying tools, maps, GPS device, measuring tape, road-design templates, field notebook, PPE.

	and structural requirements involved in culvert construction. 1.6 Describe the construction of a forest camp. 1.7 Outline the advantages and limitations of various camp construction materials. 1.8 Explain the importance of routine and periodic road maintenance for sustainable	structural requirements involved in culvert construction. • Describe the construction of a forest camp. • Highlight the advantages and limitations of the various camp construction materials in terms of durability, cost, and field practicality. • Discuss the importance of routine and periodic road maintenance		• Construct a simple field camp shelter. • Inspect a forest road section and identify maintenance needs.	• Construct a simple field camp shelter. • Inspect a forest road section and identify maintenance needs.	
GENERAL OBJECTIVE 2.0: Know the process of obtaining forest concessions in Nigeria						
3-4	2.1 Explain forest concession and its role in commercial timber production. 2.2 Describe the legal and administrative process of securing a forest concession in Nigeria. 2.3 Describe among the various types of	• Discuss forest concession and its role in commercial timber production. • Explain the legal and administrative process of securing a forest concession in Nigeria. • Explain among the various types of forest concessions available	forest-operation manuals, topographic maps, engineering drawings, equipment charts, safety codes, computer, projector,	• Perform review of a sample forest concession agreement document. • Compute a simple concession payment estimate using OTV and area-based methods given	• Perform review of a sample forest concession agreement document. • Compute a simple concession payment estimate using OTV and area-based methods given sample data.	Surveying tools, maps, GPS device, measuring tape, road-design templates, field notebook, PPE.

	forest concessions available in Nigeria. 2.4 Explain the advantages and disadvantages of the various types of forest concessions. 2.5 Explain the criteria and methods used for payment of concession rights to forest owners in Nigeria.	in Nigeria. • Discuss the advantages and disadvantages of the various types of forest concessions. • Discuss the criteria and methods used for payment of concession rights to forest owners in Nigeria, including Over-turn Volume (OTV) and area-based payment systems.	internet resources.	sample data. • Demonstrate or model forest concession • Identify the legal and administrative process of securing a forest concession in Nigeria • Document the legal and administrative process of securing a forest concession in Nigeria	• Demonstrate or model forest concession • Identify the legal and administrative process of securing a forest concession in Nigeria • Document the legal and administrative process of securing a forest concession in Nigeria	
GENERAL OBJECTIVES 3.0: Understand the techniques of timber and pulpwood harvesting						
5-6	3.1 Describe various types of forest concessions available in Nigeria. 3.2 Explain the advantages and disadvantages of the various types of forest concessions. 3.3 Describe the criteria and methods used for payment of concession rights to forest owners in Nigeria	• Discuss various types of forest concessions available in Nigeria. • Discuss the advantages and disadvantages of the various types of forest concessions. • Explain the criteria and methods used for payment of concession rights to forest owners in Nigeria	forest-operation manuals, topographic maps, engineering drawings, equipment charts, safety codes, computer, projector, internet resources.	• Handle basic harvesting tools and equipment. • Record the function of each. • Assess a standing tree. • Determine the appropriate direction of fall considering lean, wind, and terrain, Limb. • Measure a felled tree or log under supervision • Mark cross-cutting	• Handle basic harvesting tools and equipment. • Record the function of each. • Assess a standing tree. • Determine the appropriate direction of fall considering lean, wind, and terrain, Limb. • Measure a felled tree or log under supervision • Mark cross-cutting	Surveying tools, maps, GPS device, measuring tape, road-design templates, field notebook, PPE.

				- positions, • Cross-cut a prepared log to specification. • Inspect the resulting logs. • Grade the resulting logs. • Prepare a concise illustrated summary of the principal operations in timber harvesting.	- positions, • Cross-cut a prepared log to specification. • Inspect the resulting logs. • Grade the resulting logs. • Prepare a concise illustrated summary of the principal operations in timber harvesting.	
GENERAL OBJECTIVE 4.0: Understand skidding as an essential operation in the harvesting system						
7-8	4.1 Explain the role of skidding in the overall harvesting system. 4.2 Describe the two principal types of skidding. 4.3 Describe the methods of skidding. 4.4 Highlight the advantages and disadvantages of each method.	• Explain the role of skidding in the overall harvesting system, including its relationship with felling, loading, and haulage. • Describe the two principal types of skidding. • Explain the methods of skidding. • Outline the advantages and disadvantages of each method.	forest-operation manuals, topographic maps, engineering drawings, equipment charts, safety codes, computer, projector, internet resources.	• Identify the skidding method in use. • Evaluate its suitability for the terrain. • Interpret the observed results. • Document the two principal types of skidding. • Analyse an assigned case on the role of skidding in the overall harvesting system, including its relationship with felling, loading, and haulage.	• Identify the skidding method in use. • Evaluate its suitability for the terrain. • Interpret the observed results. • Document the two principal types of skidding. • Analyse an assigned case on the role of skidding in the overall harvesting system, including its relationship with felling, loading, and haulage.	Surveying tools, maps, GPS device, measuring tape, road-design templates, field notebook, PPE.

GENERAL OBJECTIVE 5.0: Understand the principles and techniques of loading and unloading harvested products						
9-10	5.1 Describe the methods of loading and securing of logs. 5.2 Explain the basic principles involved in each of the methods. 5.3 Explain hand loading, gravity loading and cross-haul loading. 5.4 Outline advantages of the selected loading method. 5.5 Explain loading and unloading procedures for harvested products.	• Discuss the methods of loading and securing of logs. • Describe basic principles involved in each of the methods. • Explain hand loading, gravity loading and cross-haul loading. • Highlight advantages of the selected loading method. • Explain loading and unloading procedures for harvested products.	forest-operation manuals, topographic maps, engineering drawings, equipment charts, safety codes, computer, projector, internet resources.	• Visit site to identify loading equipment. • Perform loading exercise. • Prepare a concise illustrated summary of the methods of loading and securing of logs. • Document the methods and basic principles involved in each of the methods. • Demonstrate hand loading, gravity loading and cross-haul loading • Analyse an assigned practical case on the methods of loading and securing of logs.	• Visit site to identify loading equipment. • Perform loading exercise. • Prepare a concise illustrated summary of the methods of loading and securing of logs. • Document the methods and basic principles involved in each of the methods. • Demonstrate hand loading, gravity loading and cross-haul loading • Analyse an assigned practical case on the methods of loading and securing of logs.	Surveying tools, maps, GPS device, measuring tape, road-design templates, field notebook, PPE.
GENERAL OBJECTIVE 6.0: Understand the major methods of transporting (hauling) harvested products to the mill						
11-12	6.1 Explain Hauling. 6.2 Describe the different methods of hauling harvested forest products. 6.3 Explain the advantages and	• Discuss hauling using relevant examples, diagrams and illustrations. • Explain the different methods of hauling	forest-operation manuals, topographic maps, engineering drawings, equipment	• Carry out hauling exercise. • Demonstrate or model hauling through an assigned practical exercise.	• Guide students to: • Perform carry out hauling exercise. • Demonstrate or model hauling through an assigned	Surveying tools, maps, GPS device, measuring tape, road-design templates,

	disadvantages of haulage method 6.4 State the conditions of haulage method	harvested forest products. • Discuss the advantages and disadvantages of haulage methods • Explain the conditions of haulage method	charts, safety codes, computer, projector, internet resources.	• Identify the different methods of hauling harvested forest products using the specified criteria.	practical exercise. • Identify the different methods of hauling harvested forest products using the specified criteria.	field notebook, PPE.
GENERAL OBJECTIVE 7.0: Understand the need for proper timber production management and sustainable forest harvesting practices						
13-15	7.1 Highlight the importance of effective production management in timber harvesting operations. 7.2 Describe strategies for reducing costs in timber harvesting 7.3 Describe safety regulations and occupational health measures in timber harvesting operations. 7.4 Describe Reduced Impact Logging (RIL). 7.5 Describe advantages of Reduced Impact Logging (RIL) over conventional	- Outline the importance of effective production management in timber harvesting operations. - Explain strategies for reducing costs in timber harvesting - Discuss safety regulations and occupational health measures in timber harvesting operations. - Explain Reduced Impact Logging (RIL). - Discuss advantages of Reduced Impact Logging (RIL) over	forest-operation manuals, topographic maps, engineering drawings, equipment charts, safety codes, computer, projector, internet resources.	- Prepare a production plan and cost estimate for a simulated timber-harvesting operation. - Conduct a safety, regulatory-compliance and Reduced Impact Logging audit of an assigned harvesting site or case study. - Evaluate product specifications, operational efficiency and environmental impacts using an approved checklist. - Develop corrective actions for identified	Guide students to: - Prepare a production plan and cost estimate for a simulated timber-harvesting operation. - Conduct a safety, regulatory-compliance and Reduced Impact Logging audit of an assigned harvesting site or case study. - Evaluate product specifications, operational efficiency and environmental impacts using an approved checklist. • Develop corrective actions for identified	Surveying tools, maps, GPS device, measuring tape, road-design templates, field notebook, PPE.

	logging.	conventional logging.		production, safety and sustainability gaps. • Assess the importance of effective production management in timber harvesting operations using the approved procedure. • Assess strategies for reducing costs in timber harvesting and adherence to forest regulations and meeting product specifications through a field or laboratory exercise.	production, safety and sustainability gaps.	
COURSE ASSESSMENT Coursework: 10% Tests: 10% Practical: 40% Examination: 40% Total: 100%						

FOREST CERTIFICATION AND TIMBER TRACEABILITY

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)		
COURSE TITLE: FOREST CERTIFICATION AND TIMBER TRACEABILITY	COURSE CODE: WPT 324	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: HND 1 SEMESTER: II	PRE-REQUISITE: NIL	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills in forest certification, timber legality, traceability systems and chain-of-custody practices.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand forest certification principles and systems; 2.0 Understand timber legality and chain-of-custody systems; 3.0 Understand timber traceability methods and documentation systems; 4.0 Know forest certification and timber traceability practices in industrial operations.		

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)						
COURSE TITLE: FOREST CERTIFICATION AND TIMBER TRACEABILITY			COURSE CODE: WPT 324		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: II			PRE-REQUISITE: NIL		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills in forest certification, timber legality, traceability systems and chain-of-custody practices.						
GENERAL OBJECTIVE 1.0: Understand forest certification principles and systems						
THEORETICAL				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1-4	1.1 Explain the concept and importance of forest certification. 1.2 Describe principles of sustainable forest management. 1.3 Explain forest certification systems and standards. 1.4 Describe benefits and challenges of forest certification. 1.5 Explain the role of certification in responsible timber production and trade.	•Describe the concept and importance of forest certification •Explain principles of sustainable forest management. •Discuss forest certification systems and standards •Discuss benefits and challenges of forest certification •Discuss the role of certification in responsible timber production and trade.	Textbooks, Charts, Computer, Projector, Internet Resources, Journal, Whiteboard, Marker, etc.	• Identify certified and non-certified timber products. • Compare labels and certification marks on wood products. • Prepare simple certification checklist for timber products. • Demonstrate the concept and importance of forest certification through an assigned practical exercise.	Guide students to: • Identify certified and non-certified timber products. • Compare labels and certification marks on wood products. • Prepare simple certification checklist for timber products. • Demonstrate the concept and importance of forest certification through an assigned practical exercise.	certification checklist, chain-of-custody forms, timber tags, barcode or QR tools, audit forms, sample records.

General Objective 2.0: Understand timber legality and chain-of-custody systems						
5-7	2.1 Explain timber legality requirements and regulations. 2.2 Describe chain-of-custody principles in timber production and marketing. 2.3 Explain procedures for timber movement and tracking. 2.4 Describe documentation requirements for legal timber trade.	• Describe timber legality requirements and regulations • Describe chain-of-custody principles in timber production and marketing • Discuss procedures for timber movement and tracking. • Discuss documentation requirements for legal timber trade	Textbooks, Charts, Computer, Projector, Internet Resources, Journal, Whiteboard, Marker, etc.	• Examine sample timber permits, waybills, invoices and chain-of-custody records for legality and completeness. • Trace a tagged timber consignment from forest source through transport, processing and marketing stages. • Complete a timber movement and tracking register using manual or digital identification codes. • Identify non-conformities • Recommend corrective actions for legal timber trade. • Demonstrate timber legality requirements and regulations through an assigned practical exercise.	Guide students to: • Examine sample timber permits, waybills, invoices and chain-of-custody records for legality and completeness. • Trace a tagged timber consignment from forest source through transport, processing and marketing stages. • Complete a timber movement and tracking register using manual or digital identification codes. • Identify non-conformities • Recommend corrective actions for legal timber trade. • Demonstrate timber legality requirements and regulations through an assigned practical exercise.	Certification checklist, chain-of-custody forms, timber tags, barcode or QR tools, audit forms, sample records.
General Objective 3.0: Understand timber traceability methods and documentation systems						

8-11	3.1 Explain timber traceability concepts and importance. 3.2 Explain timber tagging, coding and labeling systems. 3.3 Describe digital and manual timber record systems. 3.4 Explain quality and inventory tracking in timber industries.	• Discuss timber traceability concepts and importance • Discuss timber tagging, coding and labeling systems. • Explain digital and manual timber record systems. • Describe quality and inventory tracking in timber industries	Textbooks, Charts, Computer, Projector, Internet Resources, Journal, Whiteboard, Marker, etc.	• Demonstrate timber traceability concepts and importance through an assigned practical exercise. • Demonstrate timber tagging, coding and labeling systems through an assigned practical exercise. • Use relevant software or digital tools • Demonstrate digital and manual timber record systems and present the output.	Guide students to: • Demonstrate timber traceability concepts and importance through an assigned practical exercise. • Demonstrate timber tagging, coding and labeling systems through an assigned practical exercise. • Use relevant software or digital tools • Demonstrate digital and manual timber record systems and present the output.	certification checklist, chain-of-custody forms, timber tags, barcode or QR tools, audit forms, sample records.
General Objective 4.0: : Know forest certification and timber traceability practices in industrial operations						
12-15	4.1 Explain industrial certification procedures and compliance requirements. 4.2 Explain timber traceability in export and local markets. 4.3 Describe quality assurance and compliance monitoring in timber industries.	• Discuss industrial certification procedures and compliance requirements • Describe timber traceability in export and local markets • Discuss quality assurance and compliance monitoring in timber industries	Textbooks, Charts, Computer, Projector, Internet Resources, Journal, Whiteboard, Marker, etc.	• Visit timber yard, forestry office or sawmill and assess traceability practices. • Conduct certification checklist. • Demonstrate industrial certification procedures and compliance requirements through an assigned practical	Guide students to: • Visit timber yard, forestry office or sawmill and assess traceability practices. • Conduct certification checklist. • Demonstrate industrial certification procedures and compliance requirements through an assigned practical	certification checklist, chain-of-custody forms, timber tags, barcode or QR tools, audit forms, sample records.

	4.4 Explain emerging trends in forest certification and digital traceability systems.	Explain emerging trends in forest certification and digital traceability systems		exercise. Demonstrate timber traceability in export and local markets through an assigned practical exercise.	exercise. Demonstrate timber traceability in export and local markets through an assigned practical exercise.	
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COURSE ASSESSMENT

Coursework: 10%

Tests: 10%

Practical: 40%

Examination: 40%

Total: 100%



WOOD WASTE UTILIZATION AND CIRCULAR BIOECONOMY

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)		
COURSE TITLE: WOOD WASTE UTILIZATION And CIRCULAR BIOECONOMY	COURSE CODE: WPT 325	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: HND 1 SEMESTER: II	PRE-REQUISITE: NIL	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills in wood waste utilization, recycling, biomass conversion and circular bioeconomy practices.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand sources, types and characteristics of wood waste; 2.0 Understand wood waste utilization and recycling technologies; 3.0 Understand biomass conversion and value addition from wood residues; 4.0 Understand circular bioeconomy principles in wood industries; 5.0 Apply wood waste utilization and circular bioeconomy practices in industrial operations. 6.0 Understand production planning principles in wood industries		

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)						
COURSE TITLE: WOOD WASTE UTILIZATION AND CIRCULAR BIOECONOMY		COURSE CODE: WPT 325		CONTACT HOURS: 4 HOURS/WEEK		
		CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK		
YEAR: I SEMESTER: II		PRE-REQUISITE: NIL		PRACTICAL: 3 HOURS/WEEK		
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills in wood waste utilization, recycling, biomass conversion and circular bioeconomy practices.						
GENERAL OBJECTIVE 1.0: Understand sources, types and characteristics of wood waste						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1-3	1.1 Explain sources of wood waste in wood industries. 1.2 Describe types of wood waste: sawdust, wood shavings, bark, chips, off-cuts and residues. 1.3 Explain causes of wood waste generation. 1.4 Explain environmental implications of poor wood waste management.	• Discuss sources of wood waste in wood industries. • Explain types of wood waste: sawdust, wood shavings, bark, chips, off-cuts and residues. • Discuss causes of wood waste generation. • Discuss environmental	Textbooks, Charts, Computer, Projector, Internet Resources, Journal, Whiteboard, Marker, etc.	• Identify and classify different wood waste materials. • Quantify wood waste generated from workshop activities. • Compare waste generation from different wood operations. • Demonstrate or model sources of wood waste in wood industries through an assigned practical exercise.	Guide students to: • Identify and classify different wood waste materials. • Quantify wood waste generated from workshop activities. • Compare waste generation from different wood operations. • Demonstrate or model sources of	Wood residues, sorting bins, balance, size-reduction equipment, briquetting or composite tools, material-balance sheets, PPE.

		implications of poor wood waste management.		• Carry out observation, identification and documentation of wood waste types: sawdust, wood shavings, bark, chips, off-cuts and residues using the specified criteria. • Demonstrate environmental implications of poor wood waste management through an assigned practical exercise.	wood waste in wood industries through an assigned practical exercise. • Carry out observation, identification and documentation of wood waste types: sawdust, wood shavings, bark, chips, off-cuts and residues using the specified criteria. • Demonstrate environmental implications of poor wood waste management through an assigned practical exercise.	
General Objective 2.0: Understand wood waste utilization and recycling technologies						
4-6	2.1 Explain methods of wood waste utilization. 2.2 Explain recycling technologies for wood residues. 2.3 Explain conversion of wood waste into useful products. 2.4 Explain waste minimization strategies in wood industries.	• Discuss methods of wood waste utilization. • Discuss recycling technologies for wood residues. • Discuss conversion of	Textbooks, Charts, Computer, Projector, Internet Resources, Journal, Whiteboard, Marker, etc.	• Produce simple recycled wood products from off-cuts and residues. • Demonstrate reuse of sawdust and wood particles in simple composite products. • Compare waste reuse	Guide students to: • Produce simple recycled wood products from off-cuts and residues. • Demonstrate reuse of sawdust and wood particles in simple composite	Wood residues, sorting bins, balance, size-reduction equipment, briquetting or composite tools,

		wood waste into useful products. • Discuss waste minimization strategies in wood industries.		methods. • Prepare recycling assessment report.	products. • Compare waste reuse methods. • Prepare recycling assessment report.	material-balance sheets, PPE.
General Objective 3.0 Understand biomass conversion and value addition from wood residues:						
7-9	3.1 Explain biomass and bioenergy concepts. 3.2 Describe briquette production from wood residues. 3.3 Explain value-added products from wood waste. 3.4 Describe benefits and limitations of biomass utilisation.	• Describe biomass and bioenergy concepts. • Discuss briquette production from wood residues. • Explain value-added products from wood waste. • Discuss benefits and limitations of biomass utilisation.	Textbooks, Charts, Computer, Projector, Internet Resources, Journal, Whiteboard, Marker, etc.	• Produce simple wood briquettes using sawdust and binder. • Compare briquette quality from different materials. • Assess burning characteristics of briquettes under controlled conditions. • Demonstrate biomass and bioenergy concepts through an assigned practical exercise.	Guide students to: • Produce simple wood briquettes using sawdust and binder. • Compare briquette quality from different materials. • Assess burning characteristics of briquettes under controlled conditions. • Demonstrate biomass and bioenergy concepts through an assigned practical exercise.	Wood residues, sorting bins, balance, size-reduction equipment, briquetting or composite tools, material-balance sheets, PPE.
General Objective 4.0: Understand circular bioeconomy principles in wood industries						
10-11	4.1 Explain circular bioeconomy principles. 4.2 Explain waste reduction and	• Discuss circular bioeconomy principles.	Textbooks, Charts, Computer,	• Classify reusable and non-reusable wood waste.	Guide students to: • Classify reusable and non-reusable	Wood residues, sorting bins,

	reuse systems in wood industries. 4.3 Explain sustainable industrial production practices. 4.4 Explain environmental and economic benefits of circular systems.	• Discuss waste reduction and reuse systems in wood industries. • Discuss sustainable industrial production practices. • Discuss environmental and economic benefits of circular systems.	Projector, Internet Resources, Journal, Whiteboard, Marker, etc.	• Develop simple waste reuse plan for wood workshop. • Demonstrate circular bioeconomy principles through an assigned practical exercise. • Demonstrate sustainable industrial production practices through an assigned practical exercise.	wood waste. • Develop simple waste reuse plan for wood workshop. • Demonstrate circular bioeconomy principles through an assigned practical exercise. • Demonstrate sustainable industrial production practices through an assigned practical exercise.	balance, size-reduction equipment, briquetting or composite tools, material-balance sheets, PPE.
General Objective 5.0: Apply wood waste utilization and circular bioeconomy practices in industrial operations						
12-13	5.1 Explain industrial waste management systems in wood industries. 5.2 Explain quality and safety considerations in waste reuse. 5.3 Explain emerging trends in biomass and circular bio-economy systems. 5.4 Explain entrepreneurship opportunities in wood waste utilization.	• Discuss industrial waste management systems in wood industries. • Discuss quality and safety considerations in waste reuse • Discuss emerging trends	Textbooks, Charts, Computer, Projector, Internet Resources, Journal, Whiteboard, Marker, etc.	• Visit sawmills, furniture workshop or biomass facility and assess waste management practices. • Evaluate wood waste utilization methods observed in industry. • Develop simple business idea on wood waste utilization. • Demonstrate industrial	Guide students to: • Visit sawmills, furniture workshop or biomass facility and assess waste management practices. • Evaluate wood waste utilization methods observed in industry. • Develop simple	Wood residues, sorting bins, balance, size-reduction equipment, briquetting or composite tools, material-balance sheets, PPE.

		in biomass and circular bio-economy systems. • Discuss entrepreneurship opportunities in wood waste utilization.		waste management systems in wood industries through an assigned practical exercise.	business idea on wood waste utilization. • Demonstrate industrial waste management systems in wood industries through an assigned practical exercise.	
General Objective 6.0: Understand production planning principles in wood industries						
14-15	6.1 Explain production planning concepts in wood industries. 6.2 Explain production workflow and scheduling. 6.3 Explain factors affecting production planning. 6.4 Explain roles of production supervision in wood industries.	• Discuss production planning concepts in wood industries. • Discuss production workflow and scheduling. • Discuss factors affecting production planning. • Discuss roles of production supervision in wood industries.	Textbooks, Charts, Computer, Projector, Internet Resources, Journal, Whiteboard, Marker, etc.	• Prepare simple production schedule for furniture or timber processing operation. • Draw workflow chart for selected wood production activity. • Compare production sequences for different wood products. • Demonstrate production planning concepts in wood industries through an assigned practical exercise. • Demonstrate production workflow and scheduling through an assigned practical	Guide students to: • Prepare simple production schedule for furniture or timber processing operation. • Draw workflow chart for selected wood production activity. • Compare production sequences for different wood products. • Demonstrate production planning concepts in wood industries	Wood residues, sorting bins, balance, size-reduction equipment, briquetting or composite tools, material-balance sheets, PPE.

				exercise.	through an assigned practical exercise. • Demonstrate production workflow and scheduling through an assigned practical exercise.	
COURSE ASSESSMENT: Course Work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						



BIODETERIORATION OF WOOD

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)		
COURSE TITLE: BIODETERIORATION OF WOOD	COURSE CODE: WPT 326	CONTACT HOURS: 3 HOURS/WEEK
	CREDIT UNIT: 3	THEORETICAL: 1 HOUR/WEEK
YEAR: 1 SEMESTER: II	PRE-REQUISITE: NIL	PRACTICAL: 2 HOURS/WEEK
GOAL: The course is designed to equip students with the knowledge and skills of agents of bio-deterioration of wood in the forest, mill yard and in service and ability to combat them.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Know wood destroying fungi 2.0 Understand the physiology of growth of wood-rotting fungi 3.0 Understand the morphological, physical and chemical changes in wood caused by wood rotting fungi 4.0 Know various wood destroying insects and their mode of action 5.0 Understand methods of prevention and control of bio deterioration of woods		

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)						
COURSE TITLE: BIODETERIORATION OF WOOD			COURSE CODE: WPT 326		CONTACT HOURS: 3 HOURS/WEEK	
			CREDIT UNIT: 3		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: II			PRE-REQUISITE: NIL		PRACTICAL: 2 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: The course is designed to equip students with the knowledge and skills of agents of bio-deterioration of wood in the forest, mill yard and in service and ability to combat them.						
GENERAL OBJECTIVE 1.0: Know wood destroying fungi.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1-3	1.1 Describe the structure of fungi. 1.2 Explain wood destroying fungi into families according to forms of their cells. 1.3 Explain the life history of fungi. 1.2 Describe: i. Pathogens of standing trees and newly felled logs; ii. Pathogens of wood in storage; iii. Pathogens of wood in construction e.g.	• Explain the structure of fungi. • Discuss wood destroying fungi into families according to forms of their cells. • Describe the life history of fungi. • Explain ✓ Pathogens of standing trees and newly felled logs; ✓ Pathogens of wood in storage; ✓ Pathogens of wood in construction e.g.	Textbooks, Charts, Computer, Projector, Internet Resources, Journal, Whiteboard, Marker, etc.	• Identify i. Pathogens of standing trees and newly felled logs; ii. Pathogens of wood in storage; iii. Pathogens of wood in construction e.g. poles, building and furniture. • Carry out observation, identification and documentation the structure of fungi using the specified criteria. • Carry out observation,	Guide students to: • Identify - Pathogens of standing trees and newly felled logs; - Pathogens of wood in storage; - Pathogens of wood in construction e.g. poles, building and furniture. • Carry out observation, identification and documentation the	Wood specimens, microscopes, culture plates, insect samples or images, preservatives, test chambers, PPE.

	poles, building and furniture.	poles, building and furniture		identification and documentation wood destroying fungi into families according to forms of their cells using the specified criteria.	structure of fungi using the specified criteria. • Carry out observation, identification and documentation wood destroying fungi into families according to forms of their cells using the specified criteria.	
General Objective 2.0: Understand the physiology of growth of wood-rotting fungi						
4-6	2.1 Explain wood as nutrient for fungi. 2.2 Describe fungi respiration. 2.3 Outline mode of action of wood destroying fungal enzymes e.g. oxidising and hydrolysing enzymes, cellulose hemicellulose, and lignin splitting enzymes etc. 2.4 Describe mode of action of wood destroying fungal	• Discuss wood as nutrient for fungi. • Explain fungi respiration. • Explain mode of action of wood destroying fungal enzymes e.g. oxidising and hydrolysing enzymes, cellulose hemicellulose, and lignin splitting enzymes etc. • Explain mode of action of wood destroying fungal enzymes • Explain the factors	Textbooks, Charts, Computer, Projector, Internet Resources, Journal, Whiteboard, Marker, etc.	• Prepare sterile wood blocks • Expose them to selected wood-decay fungi under controlled laboratory conditions., Vary moisture, temperature or pH conditions • Monitor fungal growth and visible decay symptoms. • Determine percentage mass loss or other measurable deterioration of exposed wood specimens. • Relate observed decay	Guide students to: • Prepare sterile wood blocks • Expose them to selected wood-decay fungi under controlled laboratory conditions., Vary moisture, temperature or pH conditions • Monitor fungal growth and visible decay symptoms. • Determine percentage mass loss	Wood specimens, microscopes, culture plates, insect samples or images, preservatives, test chambers, ppe.

	enzymes. 2.5 Outline the factors determining the growth of wood destroying fungi 2.6 Describe the factors determining the growth of wood destroying fungi in.	determining the growth of wood destroying fungi e.g. moisture content of wood, temperature, PH, light etc. • Explain the factors determining the growth of wood destroying fungi.		patterns to fungal respiration, enzyme action and environmental growth factors. • Demonstrate wood as nutrient for fungi through an assigned practical exercise. • Carry out observation, identification and documentation fungi respiration using the specified criteria.	or other measurable deterioration of exposed wood specimens. • Relate observed decay patterns to fungal respiration, enzyme action and environmental growth factors. • Demonstrate wood as nutrient for fungi through an assigned practical exercise. • Carry out observation, identification and documentation fungi respiration using the specified criteria.	
General Objective 3.0: Understand the morphological, physical and chemical changes in wood caused by wood-rotting fungi						
7-9	3.1 Describe the symptoms of fungi decay 3.2 Explain the effects of fungal decay on, including i. Physical properties of wood e.g. density, colour, shrinkage, etc.	• Explain the symptoms of fungi decay e.g. change in color, change of odour, density and softness. • Discuss the effects of fungal decay on, including i. Physical properties of wood e.g.	Textbooks, Charts, Computer, Projector, Internet Resources, Journal, Whiteboard, Marker, etc.	• Identify symptoms of fungi decay e.g. change in color, change of odour, density and softness. • Classify wood-rotting fungi into brown rot, white rot and soft rot. • Describe the morphological changes	Guide students to: • Identify symptoms of fungi decay e.g. change in color, change of odour, density and softness. • Classify wood-rotting fungi into brown rot, white rot and soft rot.	Wood specimens, microscopes, culture plates, insect samples or images, preservatives, test chambers,

	ii. Electrical and thermal properties of wood. iii. Mechanical properties of wood. 3.3 Describe wood-rotting fungi into: i. Brown rot ii. White rot iii. Soft rot. 3.4 Describe the morphological changes produced in wood by brown rot, white rot and soft rot. 3.5 Explain the chemical changes that occur in wood during fungal decay 3.6 Outline the conditions necessary for the growth of wood-rotting fungi	density, colour, shrinkage, etc, ii. (Electrical and thermal properties of wood. iii. Mechanical properties of wood e.g. hardness, strengths, etc. • Explain wood-rotting fungi into: ✓ Brown rot ✓ White rot ✓ Soft rot • Explain the morphological changes produced in wood by brown rot, white rot and soft rot • Discuss the chemical changes that occur in wood during fungal decay e.g. breakdown of cellulose, hemicellulose and lignin • Explain the conditions necessary for the growth of wood-rotting fungi e.g. moisture, temperature, air and food.		produced by each type of rot. • Identify the chemical changes in wood during fungal decay. • Identify the conditions necessary for the growth of wood-rotting fungi.	• Describe the morphological changes produced by each type of rot. • Identify the chemical changes in wood during fungal decay. • Identify the conditions necessary for the growth of wood-rotting fungi.	PPE.
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General Objective 4.0: Know various wood destroying insects and their mode of action						
10-12	4.1 Describe insects and fungal attack on wood. 4.2 Describe mode of attack of wood destroying insects on: - Standing trees and newly felled logs - Seasoned and partly seasoned logs and sawn timber in storage 4.3 Describe the life cycle of wood-destroying insects. 4.4 Describe the signs of insect attack on wood 4.5 Outline the conditions that favour insect attack on wood 4.6 Explain the economic importance of insect damage to wood and timber.	• Explain insects and fungal attack on wood. • Explain mode of attack of wood destroying insects on; - Standing trees and newly felled logs - Seasoned and partly seasoned logs and sawn timber in storage • Explain the life cycle of wood-destroying insects • Explain the signs of insect attack on wood • Explain the conditions that favour insect attack on wood • Discuss the economic importance of insect damage to wood and timber	Textbooks, Charts, Computer, Projector, Internet Resources, Journal, Whiteboard, Marker, etc.	• Identify insects attack on wood, fungal attack on wood. • Identify insect attack on, Standing trees and newly felled logs • Identify the life cycle of wood-destroying insects. • Identify the signs of insect attack on wood.	Guide students to: • Identify insects attack on wood, fungal attack on wood. • Identify insect attack on, Standing trees and newly felled logs • Identify the life cycle of wood-destroying insects. • Identify the signs of insect attack on wood.	wood specimens, microscopes, culture plates, insect samples or images, preservatives, test chambers, PPE.
General Objective 5.0: Understand methods of prevention and control of bio deterioration of woods						
13-15	5.1 Explain wood bio deterioration prevention and control and their	• Discuss wood bio deterioration prevention and control and their importance	Textbooks, Charts, Computer, Projector,	• Carry out the following methods of prevention and control of wood bio	Guide students to: • Carry out the following methods of	Wood specimens, microscopes, culture plates,

	importance. 5.2 Describe the following methods of prevention and control of wood biodeterioration: Moisture control, Chemical treatment, Natural durability. 5.3 Explain the application of nanotechnology in the prevention and control of wood bio deterioration.	• Explain the following methods of prevention and control of wood bio deterioration; Moisture control, Chemical treatment, Natural durability. • Discuss the application of Nanotechnology in the prevention and control of wood bio deterioration.	Internet Resources, Journal, Whiteboard, Marker, etc.	deterioration; - Moisture control, - Chemical treatment, - Natural durability.	prevention and control of wood bio deterioration; - Moisture control, - Chemical treatment, - Natural durability.	insect samples or images, preservatives, test chambers, PPE.
COURSE ASSESSMENT: Course Work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

PULPING PROCESSES

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)		
COURSE TITLE:PULPING PROCESSES	COURSE CODE: WPT 327	CONTACT HOURS: 3 HOURS/WEEK
	CREDIT UNIT: 3	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: II	PRE-REQUISITE: NIL	PRACTICAL: 2 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills in the chemistry and technology of pulp manufacture.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Know the pulp and paper properties of various fibrous raw materials; 2.0 Understand various pulping processes and their principles of operation; 3.0 Understand the processes of pulp purification, bleaching and finishing; 4.0 Understand pulp production in the laboratory.		

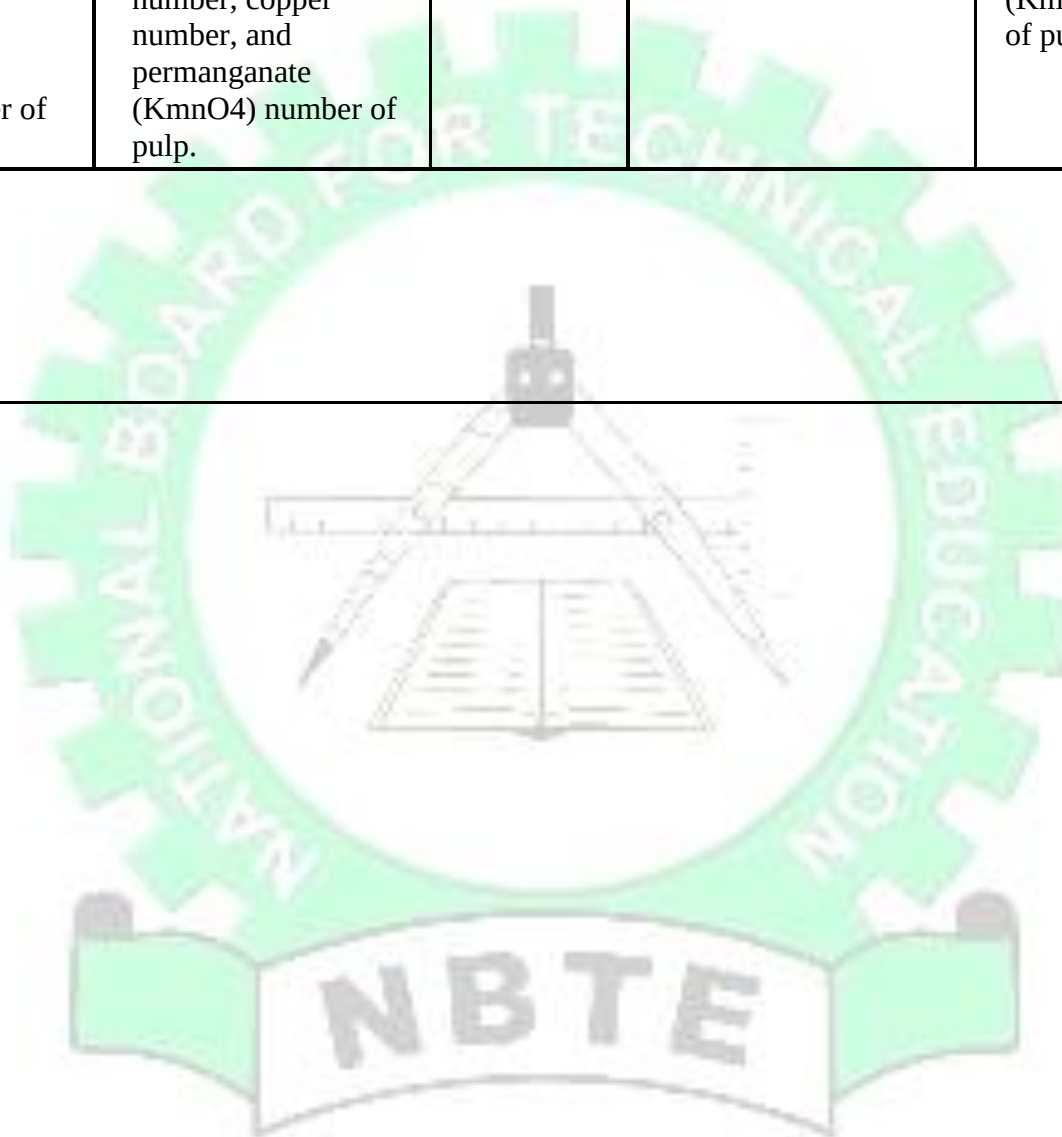
PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)						
COURSE TITLE: PULPING PROCESSES			COURSE CODE: WPT 327		CONTACT HOURS: 3 HOURS/WEEK	
			CREDIT UNIT: 3		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: II			PRE-REQUISITE:		PRACTICAL: 2 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills in the chemistry and technology of pulp manufacture.						
GENERAL OBJECTIVE 1.0: Know the pulp and paper properties of various fibrous raw materials.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1–3	1.1 Describe materials for pulping. 1.2 Describe the similarities, differences and selection criteria relating to hardwood and softwood 1.3 Describe the pulping characteristics of hardwood and softwood.	•Explain materials for pulping. •Discuss the similarities, differences and selection criteria relating to hardwood and softwood. •Explain the pulping characteristics of hardwood and softwood	Textbooks, Charts, Computer, Projector, Internet Resources, Journal, Whiteboard, Marker, etc.	• Identify materials for pulping. • Compare hardwood and softwood. • Demonstrate materials for pulping using the approved procedure and record observations.	Guide students to: • Identify materials for pulping. • Compare hardwood and softwood. • Demonstrate materials for pulping using the approved procedure and record observations.	Fibre Samples, Chipper or Sample Chips, Digester or Autoclave, Refiners, Screens, Laboratory Glassware, Chemicals, Balance, PPE.
General Objective 2.0: Understand various pulping processes and their principles of operation.						
4-6	2.1 Outline pulp-mill operations. 2.2 Explain the impact of	•Outline pulp-mill operations •Explain the impact of	Textbooks, Charts, Computer,	• Prepare wood raw material for pulping by debarking, splitting,	Guide students to: • Prepare wood raw material for pulping	Fibre Samples, Chipper or

	wood chip characteristics on pulp yield and properties 2.3 Describe mechanical pulping routes and their selection criteria 2.4 Describe semi-chemical and neutral sulphite semi-chemical pulping 2.5 Explain sulphite, soda, and kraft pulping processes 2.6 Explain chemical-recovery objectives and operations in sulphite and kraft pulp mills.	wood chip characteristics on pulp yield and properties • Describe mechanical pulping routes and their selection criteria • Explain semi-chemical and neutral sulphite semi-chemical pulping • Discuss sulphite, soda and kraft pulping processes • Explain the analytical procedure and interpretation of chemical-recovery objectives and operations in sulphite and kraft pulp mills.	Projector, Internet Resources, Journal, Whiteboard, Marker, etc.	chipping, screening and washing. • Produce a laboratory sample of mechanical pulp using an available grinder or refiner and record operating variables. • Apply a selected chip pre-treatment • atory semi-chemical under specified liquor and cooking conditions. • Produce a laboratory sulphite, soda or kraft pulp while controlling liquor composition, temperature and cooking time. • Calculate relevant alkali, causticity or sulphidity values • Determine pulp yield and basic quality indices. • Prepare a process-flow diagram for chemical recovery • Propose one closed-loop or green-chemistry improvement.	by debarking, splitting, chipping, screening and washing. • Produce a laboratory sample of mechanical pulp using an available grinder or refiner and record operating variables. • Apply a selected chip pre-treatment • Compare the resulting SGW, RMP, TMP or CMP pulp characteristics. • Prepare a laboratory semi-chemical or NSSC pulp under specified liquor and cooking conditions. • Produce a laboratory sulphite, soda or kraft pulp while controlling liquor composition, temperature and cooking time.	Sample Chips, Digester or Autoclave, Refiners, Screens, Laboratory Glassware, Chemicals, Balance, PPE.
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					• Calculate relevant alkali, causticity or sulphidity values • Determine pulp yield and basic quality indices. • Prepare a process-flow diagram for chemical recovery • Propose one closed-loop or green-chemistry improvement.	
General Objective 3.0 Understand the processes of pulp purification, bleaching and finishing						
7-10	3.1 Describe the pulp purification processes washing and cleaning. 3.2 Explain the aims of pulp purification bleaching and finishing. 3.3 Describe the various bleaching processes. 3.4 Describe the various Pulps finishing processes e.g. lap formation, pressing, drying types and baling. 3.5 Describe pulp purification. 3.6 Describe pulp bleaching.	• Explain the pulp purification processes washing and cleaning. • Discuss the aims of pulp purification bleaching and finishing • Explain the various bleaching processes • Explain the various Pulps finishing processes e.g. lap formation, pressing, drying types and baling • Explain pulp purification.	Textbooks, Charts, Computer, Projector, Internet Resources, Journal, Whiteboard, Marker, etc.	• Perform purify pulp, Bleach pulp, Finish pulp. • Carry out observation, identification and documentation the pulp purification processes washing and cleaning using the specified criteria. • Demonstrate the aims of pulp purification bleaching and finishing through an assigned practical exercise. • Carry out observation, identification and	Guide students to: • Perform purify pulp, Bleach pulp, Finish pulp. • Carry out observation, identification and documentation the pulp purification processes washing and cleaning using the specified criteria. • Demonstrate the aims of pulp purification bleaching and	Fibre Samples, Chipper or Sample Chips, Digester or Autoclave, Refiners, Screens, Laboratory Glassware, Chemicals, Balance, PPE.

	3.7 Describe pulp finishing.	• Explain pulp bleaching with relevant examples, diagrams or case materials. • Explain pulp finishing		documentation the various bleaching processes using the specified criteria.	finishing through an assigned practical exercise. • Carry out observation, identification and documentation the various bleaching processes using the specified criteria.	
General Objective 4.0 Understand pulp production in the laboratory.						
11-15	4.1 Explain analysis of pulping liquor. 4.2 Describe mill manufacture of chlorine sodium hydroxide, sodium hypochlorite and chlorine dioxide. 4.3 Describe water treatment process and steam generation. 4.4 Describe production of chemical pulp using the autoclave. 4.5 Explain ground wood pulp and chemical pulp by tests. 4.6 Explain chlorine number, kappa	• Discuss analysis of pulping liquor • Explain mill manufacture of chlorine sodium hydroxide, sodium hypochlorite and chlorine dioxide • Explain water treatment process and steam generation. • Explain production of chemical pulp using the autoclave • Discuss ground wood pulp and chemical pulp by tests. • Discuss chlorine number, kappa	Textbooks, Charts, Computer, Projector, Internet Resources, Journal, Whiteboard, Marker, etc.	• Analyse pulping liquor. • Prepare pulp samples in the sprout laboratory refiner. • Produce chemical pulp using the autoclave. • Identify ground wood pulp and chemical pulp by tests. • Determine chlorine number, kappa number, copper number, and permanganate (KmnO4) number of pulp.	Guide students to: • Analyse pulping liquor. • Prepare pulp samples in the sprout laboratory refiner. • Produce chemical pulp using the autoclave. • Identify ground wood pulp and chemical pulp by tests. • Determine chlorine number, kappa number, copper number, and permanganate	Fibre Samples, Chipper or Sample Chips, Digester or Autoclave, Refiners, Screens, Laboratory Glassware, Chemicals, Balance, PPE.

	number, copper number, and permanganate (KmnO4) number of pulp.	number, copper number, and permanganate (KmnO4) number of pulp.			(KmnO4) number of pulp.	
COURSE ASSESSMENT: Course Work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						





YEAR II SEMESTER I

PAPER TESTING AND QUALITY CONTROL

PROGRAMME: HIGHER NATIONAL DIPLOMA IN PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION		
COURSE TITLE: PAPER TESTING AND QUALITY CONTROL	COURSE CODE: PPP 411	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: 1I SEMESTER:1	PRE-REQUISITE: NIL	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is design to equip the students with the knowledge and skills required to test, evaluate, and control the quality of paper and paper products using standard national and international test methods.		
GENERAL OBJECTIVES On completion of this course, the students should be able to: 1.0 Understand the principles and importance of paper testing and quality control in the paper and paper products industry. 2.0 Understand the physical and structural properties of paper and the testing methods. 3.0 Understand the mechanical and strength properties of paper and the testing methods. 4.0 Understand the optical, surface, and chemical properties of paper and the testing methods. 5.0 Know the quality specifications for major pulp and paper grades. 6.0 Know statistical process control and measurement systems analysis in paper and paper products manufacturing. 7.0 Know quality management system standards in paper and paper products operations. 8.0 Know troubleshooting methods for pulp and paper quality defects.		

PROGRAMME: HIGHER NATIONAL DIPLOMA (HND) IN PAPER AND PAPER PRODUCTS TECHNOLOGY						
COURSE TITLE: PAPER TESTING AND QUALITY CONTROL			COURSE CODE: PPP 411		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR II	SEMESTER I		PRE-REQUISITE: NIL		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is design to equip the students with the knowledge and skills required to test, evaluate, and control the quality of paper and paper products using standard national and international test methods.						
GENERAL OBJECTIVE 1.0: Understand the principles and importance of paper testing and quality control in the paper and paper products industry						
Week	THEORETICAL			PRACTICAL CONTENT		
	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1-3	1.1 Define paper testing and quality control 1.2 Explain the importance in ensuring product consistency 1.3 Describe the relationship between raw material quality, process control, and final paper product quality. 1.4 Explain the major national and international	- Discuss paper testing and quality control - Explain the importance in ensuring product consistency - Describe the relationship between raw material quality, process control, and final paper product quality. - Explain the major national and international	Quality failure case studies, Standards comparison charts, Supply chain diagrams, Projector, Whiteboard.	- Identify the major national and international standards organisations relevant to paper testing. - Carry out standard paper testing procedures.	- Identify the major national and international standards organisations relevant to paper testing. - Carry out standard paper testing procedure	Quality failure case studies, Standards comparison charts, Supply chain diagrams, ISO Standards, TAPPI methods, Standard operating procedures (SOPs). Balance, Caliper, Micrometer, Tensile tester. Elmendorf tear tester, Moisture analyser, Colorimeter

	standards organisations relevant to paper testing 1.5 Describe the role of each in 1.4 1.6 Describe the standard conditions for paper testing 1.7 Explain the importance of controlled testing environments for reproducible results 1.8 Explain accuracy, precision, repeatability, and reproducibility in paper testing	standards organisations relevant to paper testing • Describe the role of each in 1.4 • Describe the standard conditions for paper testing • Explain the importance of controlled testing environments for reproducible results • Explain the concepts of accuracy, precision, repeatability, and reproducibility as they apply to paper testing procedures.			S.	
GENERAL OBJECTIVE 2.0: Understand the physical and structural properties of paper and their testing methods						
4-5	2.1 Explain the significance of grammage (basis weight) 2.2 Describe the	- Explain the concept of paper formation and - Describe its influence on	Paper samples of different grades, Analytical balance, Caliper gauge, Cutting	Determine the grammage, caliper, and bulk of assigned paper samples using standard methods.	Guide students to: • Determine the grammage, caliper, and	Paper samples, Analytical balance, Caliper gauge, Cutting template, Light box, Oven,

	standard method of grammage determination. 2.3 Describe the methods of measuring paper thickness (caliper) and bulk 2.4 Explain the concept of paper formation 2.5 Describe its influence on uniformity and printability. 2.6 Describe the methods used to determine moisture content in paper 2.7 Explain the effect of moisture variation on paper properties and performance. 2.8 Explain the concept of paper ash content and describe the standard method for its determination	uniformity and printability. • Describe the methods used to determine moisture content in paper • Explain the concept of paper formation • Describe its influence on uniformity and printability. • Describe the methods used to determine moisture content in paper • Explain the effect of moisture variation on paper properties and performance. • Explain the concept of paper ash content and describe the standard method for its determination	template, Light box, Projector, Whiteboard. Drying oven, Muffle furnace, Projector, Whiteboard.	Determine the moisture content and ash content of calculate results and compare against typical standard ranges.	bulk of assigned paper samples using standard methods. Determine the moisture content and ash content of calculate results and compare against typical standard ranges.	Furnace, Data recording sheets. Crucible, desiccator
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GENERAL OBJECTIVE 3.0: Understand the mechanical and strength properties of paper and their testing method						
6-7	3.1 Explain the concept of tensile strength in paper 3.2 Describe the standard method for the determination of tensile strength 3.3 Describe the Elmendorf tear test method 3.4 Explain the significance of tear resistance in relation to paper end-use applications. 3.5 Explain the Mullen burst test method 3.6 Describe the importance of burst strength in packaging and industrial paper grades. 3.7 Describe the methods used to determine internal bond strength and surface strength	• Explain the concept of tensile strength in paper • Describe the standard method for the determination of tensile strength • Describe the Elmendorf tear test method • Explain the significance of tear resistance in relation to paper end-use applications. • Explain the Mullen burst test method • Describe the importance of burst strength in packaging and industrial paper grades. • Describe the methods used to determine	Tensile tester, Elmendorf tear tester, Mullen burst tester, stress-strain diagrams, projector, whiteboard.	• Determine the tensile strength, tear resistance, and burst strength of assigned paper samples; • calculate tensile index, tear index, and burst index; record and interpret results. • Determine the stiffness and ring crush strength of board samples; • conduct a wax pick surface strength test; compare results against standard packaging specifications.	Guide students to: • Determine the tensile strength, tear resistance, and burst strength of assigned paper samples • Calculate tensile index, tear index, and burst index; record and interpret results. • Determine the stiffness and ring crush strength of board samples • conduct a wax pick surface strength test; compare results against standard packaging	Tensile tester, Elmendorf tear tester, Mullen burst tester, Sample cutter, Data recording sheets, Calculators. Taber stiffness tester, Ring crush tester, Wax pick sticks, Sample cutter, standard specification sheets, Data recording sheets.

	3.8 Explain the relevance OF 3.7 to printing and converting operations. 3.9 Explain the concept of stiffness and bending resistance in paper and board 3.10 Describe standard methods for measuring compression strength in paperboard including RCT, ECT, and SCT 3.11 Explain their importance in packaging performance.	internal bond strength and surface strength - Describe the relevance OF 3.7 to printing and converting operations. - Explain the concept of stiffness and bending resistance in paper and board - Describe standard methods for measuring compression strength in paperboard including RCT, ECT, and SCT - Explain their importance in packaging performance.			specifications.	
GENERAL OBJECTIVE: 4.0 Understand the optical, surface, and chemical properties of paper and their testing methods						
8-9	4.1 Explain the optical properties of paper: brightness,	Explain the optical properties of paper brightness, whiteness, opacity,	Projector, Whiteboard. Journal	Measure the brightness and opacity of assigned paper samples using	ide students to: Measure the brightness and opacity of	Spectrophotometer or brightness tester, Paper samples, Opacity backing

	whiteness, opacity, and colour 4.2 Describe the importance of 4.1 in printing, writing, and specialty paper applications. 4.3 Describe the standard methods for measuring paper brightness and whiteness using ISO and TAPPI methods 4.4 Explain the difference between the two above measurements. 4.5 Explain the concept of opacity 4.6 Describe the standard method for its determination. 4.7 Describe the methods used to measure paper smoothness and	and colour • Describe the importance of 4.1 in printing, writing, and specialty paper applications. • Describe the standard methods for measuring paper brightness and whiteness using ISO and TAPPI methods • Explain the difference between the two above measurements. • Explain the concept of opacity and describe the standard method for its determination. • Describe the methods used to measure paper smoothness and surface roughness including Bekk, Sheffield, and PPS methods.		available optical testing equipment • Record results against standard specification values. • Determine the smoothness and Cobb sizing value of assigned paper samples • Record results against specification • Interpret results against specification • Determine the pH of assigned paper samples using cold and hot water extract methods • conduct fibre furnish analysis using microscopic staining Record all results.	assigned paper samples using available optical testing equipment • Record results against standard specification values. • Determine the smoothness and Cobb sizing value of assigned paper samples • Record results against specification • Interpret results against specification • Determine the pH of assigned paper samples using cold and hot water extract methods • conduct fibre	plates, Data recording sheets. Smoothness tester, Cobb sizing tester, Stopwatch, Water, pH meter, Buffer solutions, Beakers, Hot plate, Microscope, Herzberg stain, Glass slides, Paper samples,.
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	surface roughness including Bekk, Sheffield, and PPS methods. 4.8 Explain the concept of paper porosity and air permeance 4.9 Describe the Gurley and Bendtsen methods for measurement 4.10 Describe the methods used to assess sizing and ink absorption including the Cobb sizing test. 4.11 Explain the importance of chemical testing in evaluating paper permanence, safety, and suitability for specific end uses. 4.12 Describe the methods used to determine the pH	• Explain the concept of paper porosity and air permeance and • Describe the Gurley and Bendtsen methods for their measurement • Describe the methods used to assess sizing and ink absorption including the Cobb sizing test. • Explain the importance of chemical testing in evaluating paper permanence, safety, and suitability for specific end uses. • Describe the methods used to determine the pH of paper cold and hot water extract methods • Explain the significance of			furnish analysis using microscopic staining Record all results.	
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	of paper cold and hot water extract methods 4.13 Explain the significance of paper pH in relation to permanence and archival quality. 4.14 Explain the significance of fibre furnish analysis Describe standard microscopic and staining methods used to identify fibre types and recycled content	paper pH in relation to permanence and archival quality. Explain the significance of fibre furnish analysis Describe standard microscopic and staining methods used to identify fibre types and recycled content				
GENERAL OBJECTIVE: 5.0 Know the quality specifications for major pulp and paper grades						
10-11	5.1 Describe the standard quality specifications for major paper grades medium. 5.2 Explain how pulp properties kappa number, viscosity, brightness, and freeness relate to end-paper quality	- Describe the standard quality specifications for major paper grades medium. - Explain how pulp properties kappa number, viscosity, brightness, and freeness relate to end-paper quality	Grade specification comparison tables, Pulp property data sheets, Finished paper Samples of each grade, Projector, Whiteboard.	- Test samples of assigned paper grades. - Measure grammage, brightness, and one strength property; Compare results against the standard specification for that grade.	Guide Students to: - Test samples of assigned paper grades; - Measure grammage, brightness, and one strength property.	Paper samples of multiple grades, Analytical balance, Brightness tester, Tensile tester, Grade specification sheets, Data recording sheets.

	and influence the properties of the finished sheet 5.3 Describe the standard acceptance and rejection criteria for pulp bales. 5.4 Explain the sampling and testing plan for incoming raw materials	and influence the properties of the finished sheet - Describe the standard acceptance and rejection criteria for pulp bales. - Explain the sampling and testing plan for incoming raw materials			Compare results against the standard specification for that grade.	
GENERAL OBJECTIVE 6.0: Know statistical process control and measurement systems analysis in paper and paper products manufacturing						
12-13	6.1 Explain the concepts of population, sample, mean, variance, standard deviation, and coefficient of variation in the context of paper quality data. 6.2 Explain Shewhart control charts X-bar, R charts, X-bar, S charts, Attribute charts	- Explain the concepts of population, sample, mean, variance, standard deviation, and coefficient of variation in the context of paper quality data. - Explain Shewhart control charts X-bar, R charts, X-bar, S charts, Attribute charts	SPC worked example handouts, Control chart templates, Paper quality data sets, Projector, Whiteboard, Calculators.	Construct an X-bar and R chart and a p-chart from assigned paper quality data sets; Identify any out-of-control points and state the chart type selected and the reason.	Guide students to: - Construct an X-bar and R chart and a p-chart from assigned paper quality data sets; - Identify any out-of-control points and state the chart type	Control chart templates, Paper quality data sheets, Calculators, Rulers, Projector.

	(p-chart, np-chart, c-chart, u-chart)	(p-chart, np-chart, c-chart, u-chart)			selected and the reason.	
6.3	Explain the conditions under which each chart type is appropriate.	Explain the conditions under which each chart type is appropriate.				
6.4	Explain out-of-control conditions on a control chart using the Western Electric rules	Explain out-of-control conditions on a control chart using the Western Electric rules				
6.5	Explain the significance of each rule in detecting process instability.	Explain the significance of each rule in detecting process instability.				
6.6	Describe process capability indices C_p and C_{pk} for a given paper quality parameter	Describe process capability indices C_p and C_{pk} for a given paper quality parameter				
6.7	Explain the difference between potential and actual capability	Explain the difference between potential and actual capability				
6.8	Explain Pareto analysis, cause-and-effect (Ishikawa) diagrams, and scatter diagrams to	Explain Pareto analysis, cause-and-effect (Ishikawa)				

	quality problem analysis in paper manufacturing. 6.9 Explain the basic measurement systems analysis (gauge R&R) for a paper testing instrument 6.10 Explain the concepts of repeatability, reproducibility, and gauge capability.	diagrams, and scatter diagrams to quality problem analysis in paper manufacturing. • Explain the basic measurement systems analysis (gauge R&R) for a paper testing instrument • Explain the concepts of repeatability, reproducibility, and gauge capability.				
GENERAL OBJECTIVE 7:0 know quality management system standards in paper and paper products operations						
14-15	7.1 Describe the ISO 9001:2015 quality management system framework -Do-Check-Act (PDCA) cycle 7.2 Explain 7.1 application in a pulp and paper mill. 7.3 Explain the concept of	• Describe the ISO 9001:2015 quality management system framework -Do-Check-Act (PDCA) cycle • Explain 7.1 application in a pulp and paper mill.	ISO 9001:2015 summary handouts, QMS clause structure diagram, Document control procedure samples, Projector, Whiteboard.	• Identify quality management system standards in paper and paper products operations. • Document audit findings Classify non-conformances Prepare corrective action requests.	Guide students to: • Identify quality management system standards in paper and paper products operations. • Document	ISO 9001:2015 summary handouts, QMS clause structure diagram, Document control procedure samples, ISO 12647 and ISPM 15 summary handouts, FSC CoC standard summary, sample SOPs Non-conformance

	document control, records management, and internal audit within an ISO 9001:2015 QMS	• Explain the concept of document control, records management, and internal audit within an ISO 9001:2015 QMS • Describe the requirements for each in 7.3 • Describe sector-specific quality and regulatory standards relevant to paper and paper products, • Explain the role of product specifications, standard operating procedures (SOPs), test plans, and non-conforming product control in maintaining consistent paper quality	ISO 12647 and ISPM 15 summary handouts, FSC CoC standard summary, Sample SOPs, Non-conformance report templates, Projector, Whiteboard. Customer complaint case studies, Relevant standard summaries, Grade-specific requirement handouts, Projector, Whiteboard. ISO 9001:2015 internal audit checklist, , Audit scenario document sets.		audit findings • Classify non-conformance s Prepare corrective action requests.	report templates, Customer complaint case studies, Relevant standard summaries, Grade-specific requirement handouts, ISO 9001:2015 internal audit checklist, Audit scenario document sets,.
7.4	Describe the requirements for each in 7.3					
7.5	Describe sector-specific quality and regulatory standards relevant to paper and paper products,					
7.6	Explain the role of product specifications, standard operating procedures (SOPs), test plans, and non-conforming product control in maintaining consistent paper quality					
7.7	Explain the principles of customer complaint management and					

	describe how quality feedback is used to drive continuous improvement in paper and paper products operations. 7.8 Describe the requirements and key test parameters of relevant paper product safety and quality standards for specific grade. 7.9 Explain simulated internal audit using a prepared checklist against ISO 9001:2015 requirements.	• Explain the principles of customer complaint management and describe how quality feedback is used to drive continuous improvement in paper and paper products operations. • Describe the requirements and key test parameters of relevant paper product safety and quality standards for specific grade Explain simulated internal audit using a prepared checklist against ISO 9001:2015 requirements.				
COURSE ASSESSMENT						

Coursework:	10%
Tests:	10%
Practical:	40%
Examination:	40%
Total:	100%



PAPER CHEMISTRY AND ADDITIVES

PROGRAMME: HIGHER NATIONAL DIPLOMA IN PAPER AND PAPER PRODUCTS TECHNOLOGY		
COURSE TITLE: PAPER CHEMISTRY AND ADDITIVES	COURSE CODE: PPP 412	CONTACT HOURS: 3 HOURS/WEEK
	CREDIT UNIT: 3	THEORETICAL: 1 HOUR/WEEK
YEAR: II SEMESTER: I	PRE-REQUISITE: NIL	PRACTICAL: 2 HOURS/WEEK
GOAL: This course is designed to provide students with knowledge and skills to apply paper chemicals and additives in producing quality paper products efficiently and sustainably.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the chemistry of water and bonding forces relevant to wet end papermaking operations. 2.0 Understand retention, drainage, and formation chemistry in the wet end of a paper machine. 3.0 Understand sizing chemistry and its application in paper and board manufacturing. 4.0 Understand strength additives and their role in paper property development. 5.0 Understand optical additives, dyes, and pigments in paper manufacturing. 6.0 Understand coating chemistry and the formulation of paper coating colours.		

PROGRAMME: HIGHER NATIONAL DIPLOMA IN PAPER AND PAPER PRODUCTS TECHNOLOGY						
COURSE TITLE: PAPER CHEMISTRY AND ADDITIVES		COURSE CODE: PPP 412		CONTACT HOURS: 3 HOURS/WEEK		
		CREDIT UNIT: 3		THEORETICAL: 1 HOUR/WEEK		
YEAR: II SEMESTER: I		PRE-REQUISITE: NIL		PRACTICAL: 2 HOURS/WEEK		
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to provide students with knowledge and skills to apply paper chemicals and additives in producing quality paper products efficiently and sustainably.						
GENERAL OBJECTIVE 1.0: Understand the chemistry of water and bonding forces relevant to wet end papermaking operations						
Week	THEORETICAL			PRACTICAL CONTENT		
	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-2	1.1 Explain the bonding forces involved in web formation, 1.2 Describe the role of each force in establishing inter-fibre bonds in the paper sheet. 1.3 Explain the importance of water quality in papermaking 1.4 Describe the key water chemistry parameters 1.5 Discuss the influence of 1.4 on wet end chemistry and paper quality.	- Explain the bonding forces involved in web formation. - Describe the role of each force in establishing inter-fibre bonds in the paper sheet. - Explain the importance of water quality in papermaking - Describe the key water chemistry parameters. - Discuss the influence of 1.4 on wet end	Molecular bonding diagrams, Paper mill Water circuit diagrams, pH meter, Conductivity meter, Hardness test kit, Projector, Whiteboard. Zeta potential diagrams, Cationic demand	- Carry out water quality measurement exercise - Demonstrate correct instrument calibration and use - Carryout result interpretation and discussion of bonding relevance. - Measure pH, conductivity, hardness, and dissolved solids in assigned paper mill water samples or simulated samples;	Guide students to: - Carry out water quality measurement exercise - Demonstrate correct instrument calibration and use - Carryout result interpretation and discussion of bonding relevance. - Measure pH, conductivity,	pH meter, Conductivity meter, Water hardness kit, TDS meter, Paper mill Water samples or simulated samples, Data recording sheets. Colloid titration kit, White water samples or simulated samples, titration worksheets, Data

	1.6 Describe the concept of the closed water system 1.7 Explain how, white-water recirculation and dissolved colloidal substance (DCS) accumulation, affect additive performance and paper quality. 1.8 Explain the concept of zeta potential and its importance in controlling fibre interactions, additive adsorption, and drainage behaviour in the wet end. 1.9 Explain the concept of cationic demand and describe the methods used to measure it in paper mill white water,	chemistry and paper quality. - Describe the concept of the closed water system - Explain how, white-water recirculation and dissolved colloidal substance (DCS) accumulation, affect additive performance and paper quality. - Explain the concept of zeta potential and its importance in controlling fibre interactions, additive adsorption, and drainage behaviour in the wet end. - Explain the concept of cationic demand and describe the methods used to measure it in paper mill white water,	measurement principle handouts, DCS case study examples, Streaming Current detector Photographs, Projector, Whiteboard.	- Record results and compare against recommended paper mill water quality standards. - Conduct a cationic demand titration on assigned white water samples using a colloid titration method; - Record results and relate to expected additive performance and web formation quality.	hardness, and dissolved solids in assigned paper mill water samples or simulated samples; - Record results and compare against recommended paper mill water quality standards. - Conduct a cationic demand titration on assigned white water samples using a colloid titration method - Record results and relate to expected additive performance and web formation quality.	recording sheets, PPE.
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GENERAL OBJECTIVE 2.0: Understand retention, drainage, and formation chemistry in the wet end of a paper machine						
3-5	2.1 Outline the mechanisms of fibre and filler retention in the wet end of a paper machine. 2.2 Explain the major classes of retention aids and the mechanism of action of each. 2.3 Describe retention systems. 2.4 Explain the conditions under which each system is applied 2.5 Describe the role of drainage aids in improving wet web dewatering on the wire and press sections. 2.6 Describe the chemistry of drainage aid adsorption onto fibres and fines. 2.7 Explain the filler retention and colloidal effects	- Outline the mechanisms of fibre and filler retention in the wet end of a paper machine. - Explain the major classes of retention aids and the mechanism of action of each. - Describe retention systems. - Explain the conditions under which each system is applied - Describe the role of drainage aids in improving wet web dewatering on the wire and press sections. - Describe the chemistry of drainage aid adsorption onto fibres and fines. - Explain the filler retention and colloidal effects on	Paper-chemistry textbooks, wet-end chemistry diagrams, additive data sheets, formulation sheets, TAPPI standards, computer, projector, internet resources.	- Conduct laboratory jar tests to evaluate the effect of varying CPAM addition levels on fibre and filler retention - Measure filtrate turbidity as a proxy for first-pass retention. - Compare the drainage rate of pulp suspensions treated with and without drainage aid - Measure drainage time using a laboratory filtration setup - Record and interpret results. - Conduct a full retention aid optimisation exercise at multiple addition levels - plot first-pass retention versus dosage - Identify the optimum	Guide students to: - Conduct laboratory jar tests to evaluate the effect of varying CPAM addition levels on fibre and filler retention - Measure filtrate turbidity as a proxy for first-pass retention. - Compare the drainage rate of pulp suspensions treated with and without drainage aid - Measure drainage time using a laboratory filtration setup - Record and interpret results.	Pulp furnish, additives, laboratory mixer, drainage apparatus, pH and conductivity meters, balance, glassware, PPE.

	on web formation and DCS content influence retention efficiency 2.8 Describe sheet uniformity 2.9 Explain the relationship between retention, drainage, formation, and paper quality. 2.10 Explain the papermaker balance competing factors to achieve target sheet properties.	web formation and DCS content influence retention efficiency - Describe sheet uniformity - Explain the relationship between retention, drainage, formation, and paper quality. - Explain the papermaker balance competing factors to achieve target sheet properties.		retention aid dosage - Submit a practical report. - Demonstrate the major classes of retention aids and the mechanism of action of each through an assigned practical exercise.	- Conduct a full retention aid optimisation exercise at multiple addition levels - plot first-pass retention versus dosage - Identify the optimum retention aid dosage - Submit a practical report. - Demonstrate the major classes of retention aids and the mechanism of action of each through an assigned practical exercise.	
GENERAL OBJECTIVE 3.0: Understand sizing chemistry and its application in paper and board manufacturing						
6-8	3.1 Outline sizing, internal sizing and surface sizing.	Outline sizing, internal sizing and surface sizing	Paper-chemistry textbooks, wet-	Prepare a series of hand sheets with varying alum-rosin	Guide students to: Prepare a series of hand sheets	pulp furnish, additives, laboratory

	3.2 State the purpose, mechanism, and conditions of application of each. 3.3 Explain the chemistry of rosin sizing and alum fixation in acidic papermaking and the limitations of acidic sizing. 3.4 Describe the influence of contact angle on liquid movement in paper 3.5 Explain contact angle theory underpins the mechanism of all internal sizing systems. 3.6 Explain the chemistry of neutral and alkaline internal sizing using alkyl ketene dimer (AKD) and alkenyl succinic anhydride (ASA). 3.7 Explain rosin, AKD, and ASA sizing systems in terms of pH range, sizing efficiency, curing behaviour, cost.	• State the purpose mechanism, and conditions of application of each. • Explain the chemistry of rosin sizing and alum fixation in acidic papermaking and the limitations of acidic sizing. • Describe the influence of contact angle on liquid movement in paper • Explain contact angle theory underpins the mechanism of all internal sizing systems. • Explain the chemistry of neutral and alkaline internal sizing using alkyl ketene dimer (AKD) and alkenyl succinic anhydride (ASA). • Explain rosin, AKD, and ASA sizing systems in terms of pH range, sizing efficiency, curing	end chemistry diagrams, additive data sheets, formulation sheets, TAPPI standards, computer, projector, internet resources.	addition levels • Determine the Cobb sizing value • Calculate size pickup for each sheet • Plot sizing degree versus alum dosage. • Prepare hand sheets internally sized with AKD or ASA at varying addition levels; determine Cobb values • Compare results against rosin-sized sheets and evaluate the efficiency of each sizing system. • Apply surface starch to assigned base paper samples using a laboratory rod coater • Measure Cobb value before and after surface sizing • Calculate size pickup • Evaluate and compare the efficiency of internal versus surface sizing	with varying alum-rosin addition levels • Determine the Cobb sizing value • Calculate size pickup for each sheet • Plot sizing degree versus alum dosage. • Prepare hand sheets internally sized with AKD or ASA at varying addition levels; determine Cobb values • Compare results against rosin-sized sheets and evaluate the efficiency of each sizing system. • Apply surface starch to assigned base	mixer, drainage apparatus, pH and conductivity meters, balance, glassware, PPE.
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	3.8 Describe environmental impact and the principles of surface sizing using starch solutions and other surface sizing agents. 3.9 Explain on paper strength, surface properties, and printability. 3.10 Explain the Cobb size 3.11 Explain size pickup for sized paper samples and sized paper and relate the results to the efficiency of the sizing method and agent used.	behaviour, cost. - Describe environmental impact and the principles of surface sizing using starch solutions and other surface sizing agents. - Explain on paper strength, surface properties, and printability. - Explain the Cobb size - Explain size pickup for sized paper samples and sized paper and relate the results to the efficiency of the sizing method and agent used.		on the same base sheet. Demonstrate or model the chemistry of neutral and alkaline internal sizing using alkyl ketene dimer (AKD) and alkenyl succinic anhydride (ASA), through an assigned practical exercise.	paper samples using a laboratory rod coater - Measure Cobb value before and after surface sizing - Calculate size pickup - Evaluate and compare the efficiency of internal versus surface sizing on the same base sheet. - Demonstrate or model the chemistry of neutral and alkaline internal sizing using alkyl ketene dimer (AKD) and alkenyl succinic anhydride (ASA), through an assigned practical	
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					exercise.	
GENERAL OBJECTIVE 4.0: Understand strength additives and their role in paper property development						
9-10	4.1 Outline dry strength and wet strength in paper. 4.2 Explain the mechanisms by which hydrogen bonding, covalent bonding, and polymer bridging contribute to paper strength development. 4.3 Describe the major dry strength additives. 4.4 Explain the mechanism of action and dosage considerations for each and the chemistry of wet strength development in paper. 4.5 Describe the application of wet strength additives. 4.6 Explain refining as a physical method of strength development.	• Explain dry strength and wet strength in paper. • Explain the mechanisms by which hydrogen bonding, covalent bonding, and polymer bridging contribute to paper strength development. • Describe the major dry strength additives. • Explain the mechanism of action and dosage considerations for each and the chemistry of wet strength development in paper. • Describe the application of wet strength additives. • Explain refining as a physical method of	Paper-chemistry textbooks, wet-end chemistry diagrams, additive data sheets, formulation sheets, TAPPI standards, computer, projector, internet resources.	• Prepare hand sheets with varying cationic starch addition levels • Determine the dry tensile strength of each sheet • Plot tensile strength versus starch dosage and identify the optimum addition level. • Prepare hand sheets with and without PAE wet strength resin • Determine wet tensile strength of each set • Calculate the wet strength retention ratio and compare against industry target values. • Prepare a concise illustrated summary of dry strength and wet strength in paper from supplied technical information. • Apply the mechanisms by which	Guide students to: • Prepare hand sheets with varying cationic starch addition levels • Determine the dry tensile strength of each sheet • Plot tensile strength versus starch dosage and identify the optimum addition level. • Prepare hand sheets with and without PAE wet strength resin • Determine wet tensile strength of each set • Calculate the wet strength retention ratio and compare against industry	pulp furnish, additives, laboratory mixer, drainage apparatus, pH and conductivity meters, balance, glassware, PPE.

	4.7 Explain chemical strength additives complement or substitute for refining energy in paper manufacturing.	strength development. Explain chemical strength additives complement or substitute for refining energy in paper manufacturing.		hydrogen bonding, covalent bonding, and polymer bridging contribute to paper strength development to an assigned practical task and document the outcome.	target values. - Prepare a concise illustrated summary of dry strength and wet strength in paper from supplied technical information. - Apply the mechanisms by which hydrogen bonding, covalent bonding, and polymer bridging contribute to paper strength development to an assigned practical task and document the outcome.	
GENERAL OBJECTIVE 5.0: Understand optical additives, dyes, and pigments in paper manufacturing						
11-13	5.1 Explain optical brightening agents (OBAs)	Explain optical brightening agents (OBAs)	Paper-chemistry textbooks, wet-	Prepare hand sheets with varying OBA addition levels	students to: Prepare hand sheets with	pulp furnish, additives, laboratory

	5.2	Describe the mechanism of action of; in converting UV light to visible blue-white fluorescence.	Describe the mechanism of action of; in converting UV light to visible blue-white fluorescence.	end chemistry diagrams, additive data sheets, formulation sheets, TAPPI standards, computer, projector, internet resources.	- Measure brightness and whiteness of each sheet; plot brightness versus OBA dosage - Identify the saturation point and optimum addition level. - Conduct a colour matching exercise Prepare hand sheets dyed at varying addition rates targeting an assigned shade - Measure colour coordinates using a spectrophotometer - Adjust addition rate and retest until the target is achieved. - Prepare hand sheets with varying PCC or kaolin addition levels - Measure brightness, opacity, and grammage - Evaluate the effect of filler type and level on optical properties and relate to FWA efficiency.	varying OBA addition levels - Measure brightness and whiteness of each sheet; plot brightness versus OBA dosage - Identify the saturation point and optimum addition level. - Conduct a colour matching exercise Prepare hand sheets dyed at varying addition rates targeting an assigned shade - Measure colour coordinates using a spectrophotometer - Adjust addition rate and retest until the target is achieved.	mixer, drainage apparatus, pH and conductivity meters, balance, glassware, PPE.
	5.3	Explain OBAs into universal, substantive, and special FWAs	Explain OBAs into universal, substantive, and special FWAs				
	5.4	Explain the conditions of application of each class.	Explain the conditions of application of each class.				
	5.5	Describe the classes of dyes used in paper manufacturing	Describe the classes of dyes used in paper manufacturing				
	5.6	Explain the mechanism of dye fixation on cellulose fibres and fillers; Describe.	Explain the mechanism of dye fixation on cellulose fibres and fillers; Describe.				
	5.7	Evaluate sources and differentiate between soluble and insoluble pigments; dye fastness; significance in	Evaluate sources and differentiate between soluble and insoluble pigments; dye fastness;				

	5.8	paper quality. Explain the effect of colour two-sidedness on paper quality	significance in paper quality.		• Prepare a concise illustrated summary of optical brightening agents (OBAs); the mechanism of action of; in converting UV light to visible blue-white fluorescence from supplied technical information.	• Prepare hand sheets with varying PCC or kaolin addition levels	
	5.9	Outline strategies for minimising colour two-sidedness in paper manufacturing	• Explain the effect of colour two-sidedness on paper quality			• Measure brightness, opacity, and grammage	
	5.10	Explain colour matching procedures in the laboratory and on the paper machine, including the use of spectrophotometric measurement, standard.	• Outline strategies for minimising colour two-sidedness in paper manufacturing			• Evaluate the effect of filler type and level on optical properties and relate to FWA efficiency.	
	5.11	Explain the major inorganic pigments and fillers used in papermaking and the effect of.	• Explain colour matching procedures in the laboratory and on the paper machine, including the use of spectrophotometric measurement, standard.			• Prepare a concise illustrated summary of optical brightening agents (OBAs); the mechanism of action of; in converting UV light to visible blue-white fluorescence from supplied technical information.	
	5.12	Evaluate on paper optical properties, bulk, and surface quality	• Explain the major inorganic pigments and fillers used in papermaking and the effect of.				
	5.13	Explain the	• Evaluate on paper optical properties, bulk,				

	variables affecting dyeing by stock addition 5.14 Describe the variables affecting Fluorescent Whitening Agent (FWA) performance in papermaking.	and surface quality • Explain the variables affecting dyeing by stock addition • Describe the variables affecting Fluorescent Whitening Agent (FWA) performance in papermaking.				
GENERAL OBJECTIVE 6.0: Understand coating chemistry and the formulation of paper coating colours						
14-15	6.1 Explain the purpose of paper coating and how coating improves optical properties, surface smoothness, printability, and barrier performance of paper and board. 6.2 Explain the major pigments used in paper coating colours and the contribution of. 6.3 Explain to coating optical properties,	• Explain the purpose of paper coating and how coating improves optical properties, surface smoothness, printability, and barrier performance of paper and board. • Explain the major pigments used in paper coating colours	Paper-chemistry textbooks, wet-end chemistry diagrams, additive data sheets, formulation sheets, TAPPI standards, computer, projector, internet resources.	• Examine assigned coated paper samples • Identify differences in surface quality, gloss, and smoothness between samples • Relate surface characteristics to the probable pigment and binder type used in each sample. • Measure the	Guide students to: • Examine assigned coated paper samples; • Identify differences in surface quality, gloss, and smoothness between samples • Relate surface characteristics to the	Pulp furnish, additives, laboratory mixer, drainage apparatus, pH and conductivity meters, balance, glassware, PPE.

	gloss, and print quality and the function of. 6.4 Explain the role of co-binders, thickeners, lubricants, cross-linkers, and dispersants in coating colour formulation. 6.5 Describe on coating rheology, runnability, and dried coating properties and the rheological behaviour of coating colours. 6.6 Explain the methods used to measure and control coating colour rheology and the common coating defects. 6.7 Evaluate Explain and as causes and corrective actions.	and the contribution of. • Explain to coating optical properties, gloss, and print quality and the function of. • Explain the role of co-binders, thickeners, lubricants, cross-linkers, and dispersants in coating colour formulation. • Describe on coating rheology, runnability, and dried coating properties and the rheological behaviour of coating colours. • Explain the methods used to measure and control coating colour rheology and the common coating defects. • Evaluate Explain		viscosity of assigned coating colour samples at different solids contents using a rotational viscometer or flow cup • Record results and plot viscosity versus solids content. • Prepare an assigned coating colour formulation • Measure its viscosity and solids content • Apply to base paper using a laboratory rod coater • Evaluate the coated surface for smoothness, brightness, and coat weight. • Demonstrate or model the major pigments used in	probable pigment and binder type used in each sample. • Measure the viscosity of assigned coating colour samples at different solids contents using a rotational viscometer or flow cup • Record results and plot viscosity versus solids content. • Prepare an assigned coating colour formulation • Measure its viscosity and solids content • Apply to base	
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		and as causes and corrective actions.		paper coating colours and the contribution of through an assigned practical exercise.	paper using a laboratory rod coater • Evaluate the coated surface for smoothness, brightness, and coat weight. • Demonstrate or model the major pigments used in paper coating colours and the contribution of through an assigned practical exercise.	
COURSE ASSESSMENT Coursework: 10% Tests: 10% Practical: 40% Examination: 40% Total: 100%						

PROCESS CONTROL AND INSTRUMENTATION

PROGRAMME: HIGHER NATIONAL DIPLOMA IN PAPER AND PAPER PRODUCTS TECHNOLOGY			
COURSE TITLE: PROCESS CONTROL AND INSTRUMENTATION		COURSE CODE: PPP 413	CONTACT HOURS: 3 HOURS/WEEK
		CREDIT UNIT: 3	THEORETICAL: 1 HOUR/WEEK
YEAR II	SEMESTER I	PRE-REQUISITE: NIL	PRACTICAL: 2 HOURS/WEEK
GOAL: This course is designed to provide students with the knowledge and skills needed to monitor, regulate, and optimize industrial processes using modern instrumentation and control systems.			
GENERAL OBJECTIVES On completion of this course, the students should be able to: 1.0 Know the ability to measure and interpret key process parameters in pulp production 2.0 Understand proficiency in implementing classical and advanced control methods 3.0 Know instrumentation data to minimize energy, water, and raw material consumption. 4.0 Understand instrumentation and control systems to prevent hazards, ensure compliance, and maintain reliable operations. 5.0 Understand digital automation, smart sensors, and industry applications in process control.			

PROGRAMME: HIGHER NATIONAL DIPLOMA (HND) IN PULP AND PAPER MAKING						
COURSE TITLE: PROCESS CONTROL AND INSTRUMENTATION			COURSE CODE: PPP 413		CONTACT HOURS: 3 HOURS/WEEK	
			CREDIT UNIT: 3		THEORETICAL: 1 HOUR/WEEK	
YEAR II	SEMESTER I		PRE-REQUISITE: NIL		PRACTICAL: 2 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to provide students with the knowledge and skills needed to monitor, regulate, and optimize industrial processes using modern instrumentation and control systems.						
GENERAL OBJECTIVE 1.0: Know the ability to measure and interpret key process parameters in pulp production.						
Week	THEORETICAL			PRACTICAL CONTENT		
	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1-3	1.1 Explain measurement of pulp flow. 1.2 Explain pressure variation in pulp production. 1.3 Explain temperature changes., the related concept. 1.4 Explain the interpretation of integrated data.	- Explain measurement of pulp flow. - Explain pressure variation in pulp production. - Explain temperature changes., the related concept. - Explain the interpretation of integrated data.	P&ID diagrams, control-loop charts, instrumentation manuals, calibration sheets, process datasets, computer, projector, internet resources.	- Measure and interpret flow rates in industrial systems. - Monitor pressure changes for process stability. - Measure and interpret temperature profiles in processes. - Monitor liquid levels.	Guide students to: - Measure and interpret flow rates in industrial systems. - Monitor pressure changes for process stability. - Measure and interpret temperature profiles in processes. - Monitor liquid levels.	process trainer, sensors, transmitters, controllers, calibration tools, computer, simulation software, data logger, PPE.

GENERAL OBJECTIVE 2.0: Understand proficiency in implementing classical and advanced control methods.						
4-5	2.1 Explain PID control. 2.2 Explain cascade control. 2.3 Explain feedforward control. 2.4 Explain model predictive control. 2.5 Describe Integrated control strategies.	• Explain PID control. • Explain cascade control. • Explain feedforward control. • Explain model predictive control. • Describe Integrated control strategies.	P&ID diagrams, control-loop charts, instrumentation manuals, calibration sheets, process datasets, computer, projector, internet resources.	• Perform tune PID parameters. • Designing cascade control systems to improve accuracy • Response feedforward strategies to anticipate and correct disturbance s. • Implement MPC for multivariable processes • Optimize performance. • Select appropriate control strategies for complex processes. • Demonstrat	Guide students to: • Perform tune PID parameters. • Designing cascade control systems to improve accuracy • Response feedforward strategies to anticipate and correct disturbances. • Implement MPC for multivariable processes • Optimize performance. • Select appropriate control strategies for complex processes. • Demonstrate or model pID control through an assigned practical exercise. • Identify	process trainer, sensors, transmitters, controllers, calibration tools, computer, simulation software, data logger, PPE.

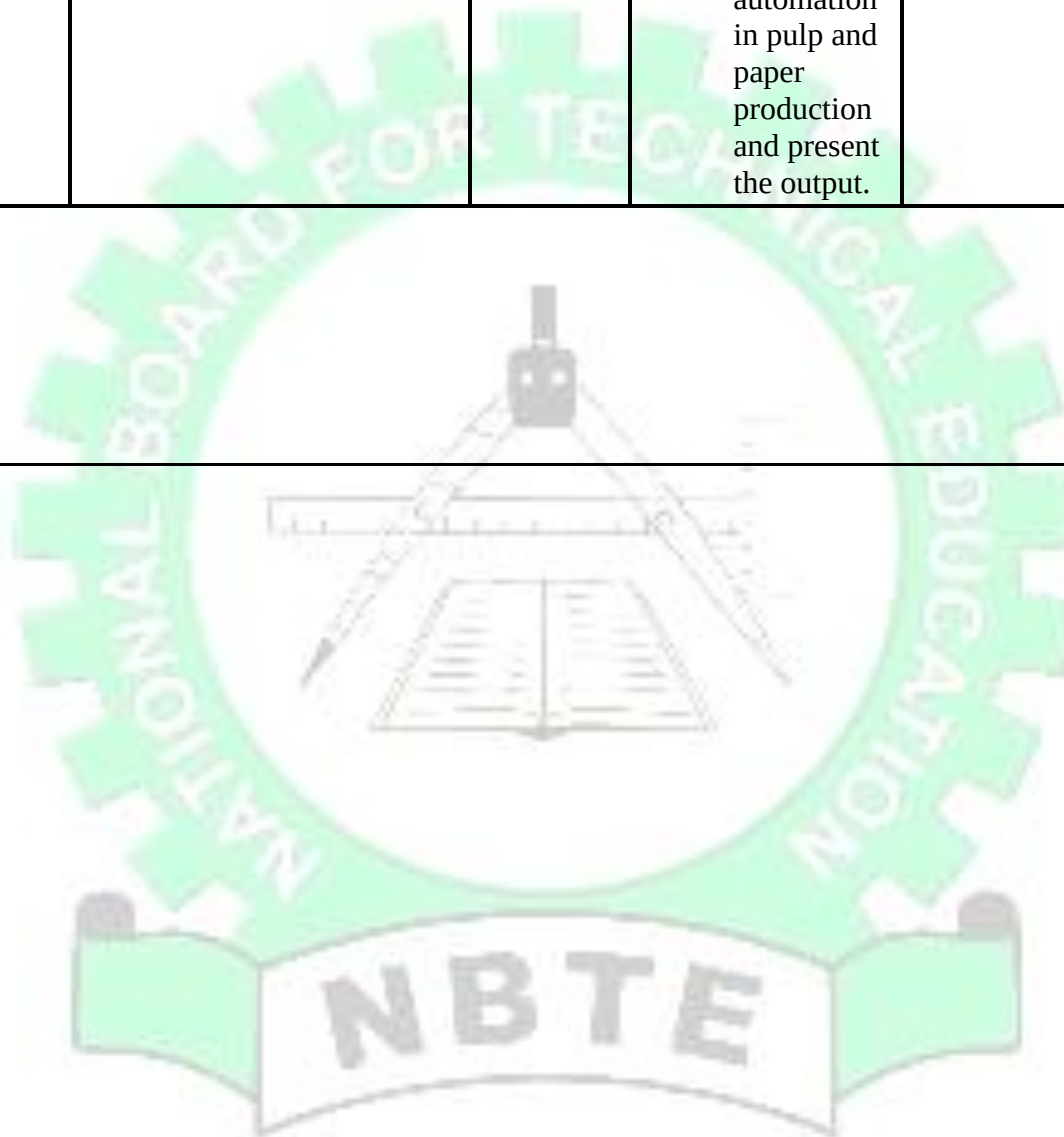
				e or model pID control through an assigned practical exercise. Identify integrated control strategies using the specified criteria.	integrated control strategies using the specified criteria.	
GENERAL OBJECTIVE 3.0: Know instrumentation data to minimize energy, water, and raw material consumption.						
6-7	3.1 Explain energy consumption in pulp and paper production. 3.2 Explain water usage pulp and paper production. 3.3 Explain raw material efficiency pulp and paper production. 3.4 Explain integrated data pulp and paper production. 3.5 Explain sustainable strategies pulp and paper production.	- Explain energy consumption in pulp and paper production. - Explain water usage pulp and paper production. - Explain raw material efficiency pulp and paper production. - Explain integrated data pulp and paper production. - Explain sustainable strategies pulp and paper production.	P&ID diagrams, control-loop charts, instrumentation manuals, calibration sheets, process datasets, computer, projector, internet resources.	- Identify energy-intensive operations and propose efficiency improvements. - Demonstrate the use of energy meters and SCADA systems - Reduce water consumption through monitoring and recycling.	Guide students to: - Identify energy-intensive operations and propose efficiency improvements. - Demonstrate the use of energy meters and SCADA systems - Reduce water consumption through monitoring and recycling. - Conduct experiments on material balances.	process trainer, sensors, transmitters, controllers, calibration tools, computer, simulation software, data logger, PPE.

				• Conduct experiments on material balances. • Demonstrate energy consumption in pulp and paper production through an assigned practical exercise.	• Demonstrate energy consumption in pulp and paper production through an assigned practical exercise.	
GENERAL OBJECTIVE: 4.0 Understand instrumentation and control systems to prevent hazards, ensure compliance, and maintain reliable operations						
8-11	4.1 Explain process hazards in pulp and paper production. 4.2 Explain regulatory compliance in pulp and paper production. 4.3 Describe reliable operations in pulp and paper production. 4.4 Explain integrated safety equipment in pulp and paper production. 4.5 Explain incident data in pulp and paper production.	• Explain process hazards in pulp and paper production. • Explain regulatory compliance in pulp and paper production. • Describe reliable operations in pulp and paper production. • Explain integrated safety equipment in pulp and paper production. • Explain incident data in pulp and paper production.	P&ID diagrams, control-loop charts, instrumentation manuals, calibration sheets, process datasets, computer, projector, internet resources.	• Perform control systems to detect and mitigate potential hazards. • Align process operations with regulatory requirements. • Design reliable	Guide students to: • Perform control systems to detect and mitigate potential hazards. • Align process operations with regulatory requirements. • Design reliable control systems that minimize downtime. • Integrate safety instrumentation into industrial	process trainer, sensors, transmitters, controllers, calibration tools, computer, simulation software, data logger, PPE.

				control systems that minimize downtime. • Integrate safety instrumentation into industrial processes. • Configure safety instrumented systems (SIS) and conducting risk assessments . • Demonstrate process hazards in pulp and paper production through an assigned practical exercise.	processes. • Configure safety instrumented systems (SIS) and conducting risk assessments. • Demonstrate process hazards in pulp and paper production through an assigned practical exercise.	
GENERAL OBJECTIVE: 5.0 Understand digital automation, smart sensors, and Industry applications in process control.						
12-15	5.1 Explain digital	• Explain digital	P&ID	• Perform	Guide students to:	process trainer,

	automation in pulp and paper production. 5.2 Explain smart sensors in pulp and paper production. 5.3 Explain the concepts of Industry, the related concept. 5.4 Describe integrate automation with data analytics. 5.5 Explain sustainability impact in pulp and paper production.	automation in pulp and paper production. • Explain smart sensors in pulp and paper production. • Explain the concepts of Industry, the related concept. • Describe integrate automation with data analytics. • Explain sustainability impact in pulp and paper production.	diagrams, control-loop charts, instrumentation manuals, calibration sheets, process datasets, computer, projector, internet resources.	configure and operate digital automation systems. • Use smart sensors for real-time monitoring and predictive maintenance. • Carryout sensor data analysis using big data tools. • Interpret data for process optimization and decision-making. • Use relevant software or digital tools to demonstrate digital	• Perform configure and operate digital automation systems. • Use smart sensors for real-time monitoring and predictive maintenance. • Carryout sensor data analysis using big data tools. • Interpret data for process optimization and decision-making. • Use relevant software or digital tools to demonstrate digital automation in pulp and paper production and present the output.	sensors, transmitters, controllers, calibration tools, computer, simulation software, data logger, PPE.
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				automation in pulp and paper production and present the output.		
COURSE ASSESSMENT Coursework: 10% Tests: 10% Practical: 40% Examination: 40% Total: 100%						



PAPERMAKING TECHNOLOGY

PROGRAMME: HIGH NATIONAL DIPLOMA IN PAPER AND PAPER PRODUCTS TECHNOLOGY			
COURSE TITLE: ADVANCED PAPERMAKING TECHNOLOGY		COURSE CODE: PPP 414	CONTACT HOURS: 4 HOURS/WEEK
		CREDIT UNIT: 4	
			THEORETICAL: 1 HOUR/WEEK
YEAR II	SEMESTER I	PRE-REQUISITE: NIL	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to provide students with knowledge and skills to understand the manufacturing of papers and the application of various paper making techniques.			
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the manufacture of various paper types. 2.0 Understand board making and paper board conversion process. 3.0 Understand physical and chemical tests in paper mill. 4.0 Know advanced theoretical principles of fibre chemistry, pulp refining, conversion mill and sheet formation. 5.0 Know strategies to minimize water, energy, and chemical consumption during paper production. 6.0 Know modern innovations such as enzymatic pulping, nanocellulose reinforcement, and biodegradable coatings. 7.0 Know innovation in value-added products economics of mill operation			

PROGRAMME: HIGH NATIONAL DIPLOMA IN PAPER AND PAPER PRODUCTS TECHNOLOGY						
COURSE TITLE: ADVANCED PAPERMAKING TECHNOLOGY			COURSE CODE: PPP 414		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR II	SEMESTER I		PRE-REQUISITE: NIL		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to provide students with knowledge and skills to understand the manufacturing of papers and the application of various paper making techniques						
GENERAL OBJECTIVE 1.0: Understand the manufacture of various paper types						
Week	THEORETICAL			PRACTICAL CONTENT		
	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1-2	1.1 Describe the principal paper grades and their specified end-use requirements. 1.2 Explain stock-preparation operations and furnish formulation by mass or volume. 1.3 Outline the treatment and sequence of addition of fibres, fillers, broke and additives. 1.4 Describe the manufacturing requirements for	- Describe the principal paper grades and their specified end-use requirements. - Explain stock-preparation operations and furnish formulation by mass or volume. - Outline the treatment and sequence of addition of fibres, fillers, broke and additives. - Describe the	Papermaking textbooks, machine diagrams, process-flow charts, quality datasets, TAPPI standards, computer, projector, internet resources.	- Prepare pulp from waste paper using laboratory pulping equipment. - Produce handmade paper sheets from recycled fibre. - Conduct strength tests (burst, tensile, tear) on various paper grades. - Identify the	- Prepare pulp from waste paper using laboratory pulping equipment. - Produce handmade paper sheets from recycled fibre. - Conduct strength tests (burst, tensile, tear) on various paper grades. - Identify the principal paper grades and their specified end-use requirements using the specified criteria.	Pulp furnish, laboratory beater or refiner, sheet former, press, dryer, machine simulator, testing instruments, PPE.

	specialty and security papers. 1.5 Explain composition and process conditions as it influence sheet quality. 1.6 Explain product-matching criteria to select a suitable furnish and process route for an assigned paper grade.	manufacturing requirements for specialty and security papers. • Explain composition and process conditions as it influence sheet quality. • Explain product-matching criteria to select a suitable furnish and process route for an assigned paper grade.		principal paper grades and their specified end-use requirements using the specified criteria.		
GENERAL OBJECTIVE 2.0: Understand board making and paper board conversion processes						
3-4	2.1 Describe furnish types and treatment for top liner under filler and bottoms. 2.2 Explain reason for coating paper. 2.3 Describe properties of coated paper. 2.4 Describe uses of coated paper.	• Describe furnish types and treatment for top liner under filler and bottoms. • Explain reason for coating paper. • Describe properties of coated paper. • Describe uses of coated paper.	Papermaking textbooks, machine diagrams, process-flow charts, quality datasets, TAPPI standards, computer, projector, internet resources.	• Perform manufacture paperboard sheets by laminating multiple pulp layers. • Determine basis weight, thickness, brightness, and opacity of different paper samples	Guide students to: • Perform manufacture paperboard sheets by laminating multiple pulp layers. • Determine basis weight, thickness, brightness, and opacity of different paper samples • Carry out paper coating using clay or calcium carbonate	Pulp furnish, laboratory beater or refiner, sheet former, press, dryer, machine simulator, testing instruments, PPE.

				• Carry out paper coating using clay or calcium carbonate coating formulations. • Demonstrate or simulate furnish types and treatment for top liner under filler and bottoms using the approved procedure and record observations. • Demonstrate or model reason for coating paper through an assigned practical exercise.	coating formulations. • Demonstrate or simulate furnish types and treatment for top liner under filler and bottoms using the approved procedure and record observations • Demonstrate or model reason for coating paper through an assigned practical exercise.	
GENERAL OBJECTIVE 3.0: Understand physical and chemical tests in paper mill.						
5-6	3.1 Describe physical and chemical tests in paper mill. 3.2 Outline the significance of the	• Describe physical and chemical tests in paper mill. • Outline the significance of the	Papermaking textbooks, machine diagrams, process-flow	• Determine the basis weight (grammage) of different	Guide students to: • Determine the basis weight (grammage) of different paper samples using	Pulp furnish, laboratory beater or refiner, sheet former, press, dryer, machine

	tests and apply the results in paper processing. 3.3 Explain the causes and control of pitch, shime and other microbiological troubles in the mill. 3.4 Explain paper defects. 3.5 Outline causes of paper defects. 3.6 Describe ways of eliminating or reducing paper defect in papermaking.	tests and apply the results in paper processing. • Explain the causes and control of pitch, shime and other microbiological troubles in the mill. • Explain paper defects. • Outline causes of paper defects. • Describe ways of eliminating or reducing paper defect in papermaking.	charts, quality datasets, TAPPI standards, computer, projector, internet resources.	paper samples using standard testing procedures. • Measure paper thickness (caliper) and calculate paper density. • Conduct moisture content analysis on paper samples using oven-drying methods. • Determine bursting strength and compare the performance of different paper grades.	standard testing procedures. • Measure paper thickness (caliper) and calculate paper density. • Conduct moisture content analysis on paper samples using oven-drying methods. • Determine bursting strength and compare the performance of different paper grades. • Carry out tear resistance tests on paper samples using standard instruments. • Measure paper brightness, opacity, and whiteness using laboratory equipment. • Determine the pH of paper and paper-making process water samples • Carry out ash content of paper samples	simulator, testing instruments, PPE.
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				• Carry out tear resistance tests on paper samples using standard instruments. • Measure paper brightness, opacity, and whiteness using laboratory equipment. • Determine the pH of paper and paper-making process water samples, Carry out ash content of paper samples through combustion testing.	through combustion testing. • Conduct water absorption (Cobb) tests and evaluate paper suitability for packaging applications.	
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				Conduct water absorption (Cobb) tests and evaluate paper suitability for packaging applications.		
GENERAL OBJECTIVE 4.0: Know advanced theoretical principles of fiber chemistry, pulp refining, conversion mill and sheet formation.						
7-8	4.1 Explain the chemical composition and bonding behaviour of cellulose, hemicellulose, and lignin in relation to papermaking fibre quality. 4.2 Explain the principles and stages of pulp refining 4.3 Explain the effects on fibre morphology and paper strength properties and the mechanisms of sheet formation in papermaking	- Explain the chemical composition and bonding behaviour of cellulose, hemicellulose, and lignin in relation to papermaking fibre quality. - Explain the principles and stages of pulp refining - Explain the effects on fibre morphology	Papermaking textbooks, machine diagrams, process-flow charts, quality datasets, TAPPI standards, computer, projector, internet resources.	- Perform refine pulp samples at different refining levels and prepare laboratory handsheets. - Examine fibre development and sheet formation and relate them to cellulose, hemicellulose	Guide students to: - Perform refine pulp samples at different refining levels and prepare laboratory handsheets. - Examine fibre development and sheet formation and relate them to cellulose, hemicellulose and lignin behaviour. - Test selected strength and	Pulp furnish, laboratory beater or refiner, sheet former, press, dryer, machine simulator, testing instruments, PPE.

	practice. 4.4 Explain the performance of paper products. 4.5 Explain the factors that cause variation 4.6 Explain the processes of e.g. Parchamentising - laminating: - crepe (sack) or extensible paper - Embossing, super calendering etc	and paper strength properties and the mechanisms of sheet formation in papermaking practice. • Explain the performance of paper products. • Explain the factors that cause variation • Explain the processes of e.g. Parchamentising - laminating: - crepe (sack) or extensible paper - Embossing, super calendering etc		se and lignin behaviour. • Test selected strength and formation properties of the handsheets and compare results. • Demonstrate at least two paper-conversion or finishing operations such as laminating, embossing, calendering, creping or parchamentising.	formation properties of the handsheets and compare results. • Demonstrate at least two paper-conversion or finishing operations such as laminating, embossing, calendering, creping or parchamentising.	
GENERAL OBJECTIVE 5.0: Know strategies to minimize water, energy, and chemical consumption during paper production						
9-10	5.1 Explain the sources and pathways of water consumption in the papermaking	• Explain the sources and pathways of water	Papermaking textbooks, machine diagrams,	• Monitor water and chemical input/output	Guide students to: • Monitor water and chemical input/output at	Pulp furnish, laboratory beater or refiner, sheet former, press,

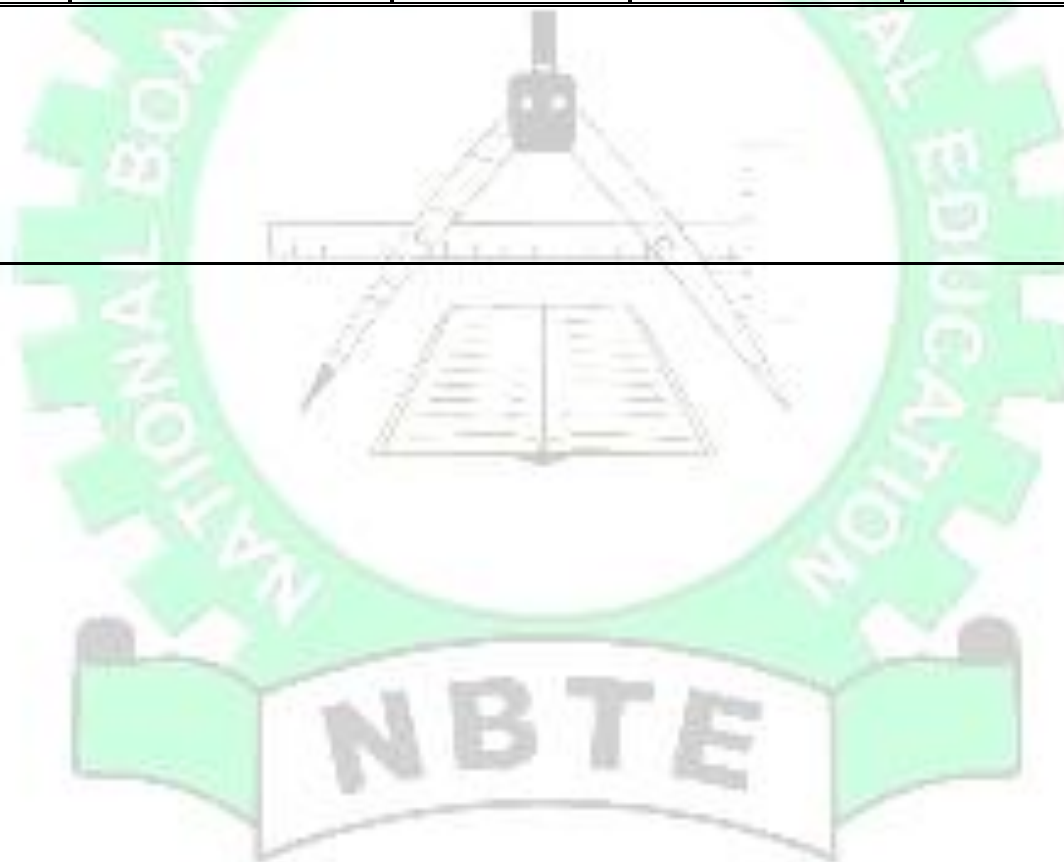
	process. 5.2 Describe strategies for water recycling and closed-loop systems. 5.3 Describe the major energy-intensive stages of paper production. 5.4 Explain methods for reducing energy demand through process optimisation and heat recovery. 5.5 Explain the role of chemicals in pulping, bleaching, and sizing,.	consumption in the papermaking process. - Describe strategies for water recycling and closed-loop systems. - Describe the major energy-intensive stages of paper production. - Explain methods for reducing energy demand through process optimisation and heat recovery. - Explain the role of chemicals in pulping, bleaching, and sizing,.	process-flow charts, quality datasets, TAPPI standards, computer, projector, internet resources.	at each wet-end stage. - Calculate specific water consumption per kg of paper produced and propose reduction strategies. - Demonstrate or model the sources and pathways of water consumption in the papermaking process through an assigned practical exercise. - Identify strategies for water recycling and closed-loop	each wet-end stage. - Calculate specific water consumption per kg of paper produced and propose reduction strategies. - Demonstrate or model the sources and pathways of water consumption in the papermaking process through an assigned practical exercise. - Identify strategies for water recycling and closed-loop systems using the specified criteria.	dryer, machine simulator, testing instruments, PPE.
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				systems using the specified criteria.		
GENERAL OBJECTIVE 6.0: Know modern innovations such as enzymatic pulping, nanocellulose reinforcement, and biodegradable coatings						
11-12	6.1 Outline the mechanism of enzymatic pulping. 6.2 Explain specific enzymes involved in mode of action on lignocellulosic biomass. 6.3 Describe the properties of nanocellulose. 6.4 Describe application as a reinforcing agent. 6.5 Explain the formulation and application of biodegradable coatings on paper substrate and environmental advantages of. 6.6 Evaluate over conventional coatings.	- Outline the mechanism of enzymatic pulping. - Explain specific enzymes involved in mode of action on lignocellulosic biomass. - Describe the properties of nanocellulose. - Describe application as a reinforcing agent. - Explain the formulation and application of biodegradable coatings on paper substrate and	Papermaking textbooks, machine diagrams, process-flow charts, quality datasets, TAPPI standards, computer, projector, internet resources.	- Perform treat pulp samples with cellulase/xy lanase enzyme at controlled temperature and time. - Measure Kappa number before and after; prepare a simple starch or carboxymet hyl cellulose (CMC) biodegradab le coating and apply to	Guide students to: - Perform treat pulp samples with cellulase/xylanase enzyme at controlled temperature and time. - Measure Kappa number before and after; prepare a simple starch or carboxymethyl cellulose (CMC) biodegradable coating and apply to handsheets. - Test water resistance (Cobb test -TAPPI T 441). - Prepare a concise illustrated summary of the	Pulp furnish, laboratory beater or refiner, sheet former, press, dryer, machine simulator, testing instruments, PPE.

		environmental advantages of. Evaluate over conventional coatings.		handsheets. - Test water resistance (Cobb test - TAPPI T 441). - Prepare a concise illustrated summary of the mechanism of enzymatic pulping, from supplied technical information.	mechanism of enzymatic pulping, from supplied technical information.	
GENERAL OBJECTIVE 7.0: Know innovation in value-added products economics of mill operation						
13-15	7.1 Explain specialty papers. 7.2 Explain eco-packaging solutions. 7.3 Describe innovative approaches to producing value-added goods from recycled paper. 7.4 Explain sustainability impact of proposed	- Explain specialty papers. - Explain eco-packaging solutions. - Describe innovative approaches to producing value-added	Papermaking textbooks, machine diagrams, process-flow charts, quality datasets, TAPPI standards, computer, projector, internet	Formulate a specialty handsheet (e.g., grease-resistant food wrap, coloured decorative sheet, or moulded	Guide students to: - Formulate a specialty handsheet (e.g., grease-resistant food wrap, coloured decorative sheet, or moulded pulp tray) - Test relevant	Pulp furnish, laboratory beater or refiner, sheet former, press, dryer, machine simulator, testing instruments, PPE.

	value-added products and the economic consideration in mill operation. 7.5 Describe production planning. 7.6 Explain economic considerations in the siting, and the layout of a new paper mill. 7.7 Explain the "A" series and Paper/Board stock sizes.	goods from recycled paper. • Explain sustainability impact of proposed value-added products and the economic consideration in mill operation. • Describe production planning. • Explain economic considerations in the siting, and the layout of a new paper mill. • Explain the "A" series and Paper/Board stock sizes.	resources.	pulp tray) • Test relevant properties, Present product with a brief value proposition statement. • Prepare a concise illustrated summary of specialty papers from supplied technical information. • Demonstrate or model eco-packaging solutions through an assigned practical exercise. • Identify innovative approaches to	properties, Present product with a brief value proposition statement. • Prepare a concise illustrated summary of specialty papers from supplied technical information. • Demonstrate or model eco-packaging solutions through an assigned practical exercise. • Identify innovative approaches to producing value-added goods from recycled paper using the specified criteria.	
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				producing value-added goods from recycled paper using the specified criteria.	
COURSE ASSESSMENT Coursework: 10% Tests: 10% Practical: 40% Examination: 40% Total: 100%					



TIMBER AND FIBRE TRACEABILITY SYSTEM

PROGRAMME: HIGH NATIONAL DIPLOMA IN PAPER AND PAPER PRODUCTS TECHNOLOGY			
COURSE TITLE: TIMBER AND FIBRE TRACEABILITY SYSTEM		COURSE CODE: PPP 415	CONTACT HOURS: 4 HOURS/WEEK
		CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR II	SEMESTER I	PRE-REQUISITE: NIL	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to provide students with knowledge and skills in timber and fibre traceability systems and technologies as applied across the timber, pulp, and paper products supply chain.			
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the concept and importance of timber and fibre traceability in the paper and paper products industry. 2.0 Understand the principles of chain of custody in timber and fibre supply chains. 3.0 Know the national and international regulatory frameworks governing timber and fibre traceability. 4.0 Understand timber and fibre certification systems and their application in paper and paper products. 5.0 Know traceability tools and technologies in timber and fibre supply chain management. 6.0 Understand fibre verification and responsible sourcing practices in paper and paper products manufacturing. 7.0 Know traceability record keeping, auditing, and reporting practices in paper and paper products operations.			

PROGRAMME: HIGH NATIONAL DIPLOMA IN PAPER AND PAPER PRODUCTS TECHNOLOGY						
COURSE TITLE: TIMBER AND FIBRE TRACEABILITY SYSTEM			COURSE CODE: PPP 415		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR II	SEMESTER I		PRE-REQUISITE: NIL		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to provide students with knowledge and skills in timber and fibre traceability systems and technologies as applied across the timber, pulp, and paper products supply chain						
GENERAL OBJECTIVE 1.0: Understand the concept and importance of timber and fibre traceability in the paper and paper products industry						
Week	THEORETICAL			PRACTICAL CONTENT		
	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1-2	1.1 Explain "traceability" 1.2 Explain scope of timber and fibre supply chains. 1.3 Describe the importance of traceability in the paper and paper products industry. 1.4 Explain the journey of timber and fibre from forest source to finished paper product. 1.5 Describe the key	- Explain "traceability" - Explain scope of timber and fibre supply chains. - Describe the importance of traceability in the paper and paper products industry. - Explain the journey of timber and fibre from forest source to finished paper product.	Traceability standards, chain-of-custody forms, barcode and RFID guides, audit templates, supply-chain diagrams, computer,	- Construct a flow diagram showing the movement of timber and fibre from source to finished paper product. - Identify critical traceability points and the information	Guide students to: - Construct a flow diagram showing the movement of timber and fibre from source to finished paper product. - Identify critical traceability points and the information to be captured at each point.	Timber or fibre samples, tags, barcode or QR scanner, RFID demonstration kit, chain-of-custody forms, computer.

	traceability points along the supply chain. 1.6 Explain timber traceability and fibre traceability and the specific challenges associated with each in paper and paper products manufacturing. 1.7 Evaluate the consequences of poor or absent traceability systems.	- Describe the key traceability points along the supply chain. - Explain timber traceability and fibre traceability and the specific challenges associated with each in paper and paper products manufacturing. - Explain the consequences of poor or absent traceability systems.	projector, internet resources.	to be captured at each point. - Assign a batch identification code - Conduct forward and backward tracing of a simulated fibre consignment. - Document the consequences of missing or inaccurate traceability information. - Prepare a concise illustrated summary of "traceability" from supplied technical information.	- Assign a batch identification code - Conduct forward and backward tracing of a simulated fibre consignment. - Document the consequences of missing or inaccurate traceability information. - Prepare a concise illustrated summary of "traceability" from supplied technical information.	
GENERAL OBJECTIVE 2.0: Understand the principles of chain of custody in timber and fibre supply chains						
3-4	2.1 Explain "chain of custody" (CoC).	Explain "chain of custody" (CoC).	Traceability	Visit forest	Guide students to: Visit forest reserve	Timber or fibre samples, tags,

	2.2 Explain its role in maintaining traceability from forest source to end product. 2.3 Describe the key stages in the chain of custody for timber and fibre. 2.4 Explain the three-principal chain of custody models. 2.5 Describe the documentation requirements at each stage of the chain of custody. 2.6 Explain the role of due diligence in chain of custody management. 2.7 Describe the steps involved in conducting a due diligence assessment for timber and fibre inputs.	• Explain its role in maintaining traceability from forest source to end product. • Describe the key stages in the chain of custody for timber and fibre. • Explain the three-principal chain of custody models. • Describe the documentation requirements at each stage of the chain of custody. • Explain the role of due diligence in chain of custody management. • Describe the steps involved in conducting a due diligence assessment for timber and fibre inputs.	standards, chain-of-custody forms, barcode and RFID guides, audit templates, supply-chain diagrams, computer, projector, internet resources.	reserve and observe traceability records. • Demonstrate or model "chain of custody" (CoC) through an assigned practical exercise. • Demonstrate maintenance of traceability from forest source to end product through an assigned practical exercise. • Identify the key stages in	and observe traceability records. • Demonstrate or model "chain of custody" (CoC) through an assigned practical exercise. • Demonstrate maintenance of traceability from forest source to end product through an assigned practical exercise. • Identify the key stages in the chain of custody for timber and fibre using the specified criteria.	barcode or QR scanner, RFID demonstration kit, chain-of-custody forms, computer.
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				the chain of custody for timber and fibre using the specified criteria.		
GENERAL OBJECTIVE 3.0: Know the national and international regulatory frameworks governing timber and fibre traceability						
5-6	3.1 Outline the key provisions of Nigerian forestry laws and regulations relevant to timber harvesting, transportation, and trade. 3.2 Explain the requirements of the EU Timber Regulation (EUTR) and the Forest Law Enforcement, Governance and Trade (FLEGT) framework. 3.3 Describe implications on Nigerian timber and paper product exports. 3.4 Explain the objectives and structure of Nigeria's	• Explain the key provisions of Nigerian forestry laws and regulations relevant to timber harvesting, transportation, and trade. • Explain the requirements of the EU Timber Regulation (EUTR) and the Forest Law Enforcement, Governance and Trade (FLEGT) framework. • Describe implications on Nigerian timber and paper product exports. • Explain the objectives and structure of Nigeria's Timber Legality Assurance	Traceability standards, chain-of-custody forms, barcode and RFID guides, audit templates, supply-chain diagrams, computer, projector, internet resources.	• Perform review sample timber harvesting, transportation and trade documents against Nigerian legality requirements. • Use a compliance checklist to assess a simulated consignment under TLAS, FLEGT and applicable export requirements. • Identify	Guide students to: • Perform review sample timber harvesting, transportation and trade documents against Nigerian legality requirements. • Use a compliance checklist to assess a simulated consignment under TLAS, FLEGT and applicable export requirements. • Identify missing, inconsistent or non-compliant records and state their implications for trade. • Prepare a brief legality-verification report with recommended corrective actions.	Timber or fibre samples, tags, barcode or QR scanner, RFID demonstration kit, chain-of-custody forms, computer.

	Timber Legality Assurance System (TLAS) 3.5 Describe in verifying the legal origin of timber and fibre. 3.6 Explain the documentation required under Nigerian law for legal timber harvesting and trade and Voluntary Partnership Agreements (VPAs) 3.7 Describe Nigeria's engagement with international timber legality frameworks. 3.8 Evaluate timber trade documents and assess their compliance with Nigerian regulatory requirements.	System (TLAS) - Describe in verifying the legal origin of timber and fibre. - Explain the documentation required under Nigerian law for legal timber harvesting and trade and Voluntary Partnership Agreements (VPAs) - Describe Nigeria's engagement with international timber legality frameworks. - Evaluate timber trade documents and assess their compliance with Nigerian regulatory requirements.		missing, inconsistent or non-compliant records and state their implications for trade. Prepare a brief legality-verification report with recommended corrective actions.		
GENERAL OBJECTIVE 4.0: Understand timber and fibre certification systems and their application in paper and paper products						
7-8	4.1 Outline forest certification 4.2 Explain the provision of market assurance of sustainable and legal timber 4.3 Explain the criteria	- Outline forest certification - Explain the provision of market assurance of sustainable and legal timber - Explain the criteria	Traceability standards, chain-of-custody forms, barcode	Compare the main FSC and PEFC requirements applicable	Guide students to: Compare the main FSC and PEFC requirements applicable to a paper and paper-products	Timber or fibre samples, tags, barcode or QR scanner, RFID demonstration kit, chain-of-custody forms,

	for Forest Stewardship Council (FSC) certification system. 4.4 Discuss the Programme for the Endorsement of Forest Certification (PEFC) system and compare. 4.5 Explain with FSC in terms of scope, criteria, and market recognition. 4.6 Describe the requirements for FSC and PEFC chain of custody certification for a paper and paper products manufacturer 4.7 Explain the certification process from initial application through audit, certification award, and annual surveillance. 4.8 Explain recycled fibre certification. 4.9 Explain verification under FSC and PEFC	for Forest Stewardship Council (FSC) certification system. • Discuss the Programme for the Endorsement of Forest Certification (PEFC) system and compare. • Explain with FSC in terms of scope, criteria, and market recognition. • Describe the requirements for FSC and PEFC chain of custody certification for a paper and paper products manufacturer • Explain the certification process from initial application through audit, certification award, and annual surveillance. • Explain recycled fibre certification. • Explain verification	and RFID guides, audit templates, supply-chain diagrams, computer, projector, internet resources.	to a paper and paper-products manufacturer. • Prepare a simple chain-of-custody procedure for receiving, storing, processing and dispatching certified fibre. • Conduct a mock certification gap assessment of an assigned enterprise. • Classify sample product claims, including certified and recycled-fibre claims, and justify their use.	manufacturer. • Prepare a simple chain-of-custody procedure for receiving, storing, processing and dispatching certified fibre. • Conduct a mock certification gap assessment of an assigned enterprise. • Classify sample product claims, including certified and recycled-fibre claims, and justify their use.	computer.
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	standards 4.10 Explain the costs, benefits, and challenges of obtaining certification for a small or medium-scale paper and paper products enterprise.	under FSC and PEFC standards Explain the costs, benefits, and challenges of obtaining certification for a small or medium-scale paper and paper products enterprise.		and recycled-fibre claims, and justify their use.		
GENERAL OBJECTIVE 5.0: Apply traceability tools and technologies in timber and fibre supply chain management						
9-10	5.1 Describe the range of tools and technologies available for timber and fibre traceability, applications. 5.2 Explain the principles of log tracking and timber marking systems. 5.3 Describe the application of GIS and remote sensing in monitoring timber harvesting areas, verifying harvest boundaries, and detecting illegal logging activities. 5.4 Explain the use of	- Describe the range of tools and technologies available for timber and fibre traceability, applications. - Explain the principles of log tracking and timber marking systems. - Describe the application of GIS and remote sensing in monitoring timber harvesting areas, verifying harvest boundaries, and detecting illegal logging activities. - Explain the use of DNA fingerprinting	Traceability standards, chain-of-custody forms, barcode and RFID guides, audit templates, supply-chain diagrams, computer, projector, internet resources.	- Identify the use of available traceability tools; match each tool to an appropriate supply chain stage. - Interpret a GIS output map of a timber harvesting area - Identify	Guide students to: - Identify the use of available traceability tools; match each tool to an appropriate supply chain stage. - Interpret a GIS output map of a timber harvesting area - Identify areas of potential boundary violation or illegal activity. - Operate a basic traceability data recording system; record, track, and produce a	Timber or fibre samples, tags, barcode or QR scanner, RFID demonstration kit, chain-of-custody forms, computer.

	DNA fingerprinting and wood anatomy analysis as scientific methods for verifying timber species. 5.5 Describe the role of digital traceability platforms and blockchain technology in improving transparency, data integrity, and real-time monitoring across the paper and paper products supply chain.	and wood anatomy analysis as scientific methods for verifying timber species. Describe the role of digital traceability platforms and blockchain technology in improving transparency, data integrity, and real-time monitoring across the paper and paper products supply chain.		areas of potential boundary violation or illegal activity. - Operate a basic traceability data recording system; record, track, and produce a traceability report for a simulated fibre intake scenario. - Demonstrate the principles of log tracking and timber marking systems through an assigned	traceability report for a simulated fibre intake scenario. Demonstrate the principles of log tracking and timber marking systems through an assigned practical exercise.	
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				practical exercise.		
GENERAL OBJECTIVE 6.0: Understand fibre verification and responsible sourcing practices in paper and paper products manufacturing						
11-12	6.1 Explain fibre verification. 6.2 Explain the importance in ensuring that paper and paper products are manufactured from legally and sustainably sourced raw materials and the categories of fibre inputs used in paper manufacturing. 6.3 Describe the traceability requirements applicable to, the related concept. 6.4 Explain the principles of responsible sourcing. 6.5 Explain how paper manufacturers assess and manage risk associated with fibre inputs from unverified or controversial sources.	• Explain fibre verification. • Explain the importance in ensuring that paper and paper products are manufactured from legally and sustainably sourced raw materials and the categories of fibre inputs used in paper manufacturing. • Describe the traceability requirements applicable to, the related concept. • Explain the principles of responsible sourcing. • Explain how paper manufacturers assess and manage risk associated with fibre inputs from unverified or controversial sources.	traceability standards, chain-of-custody forms, barcode and RFID guides, audit templates, supply-chain diagrams, computer, projector, internet resources.	• Classify virgin, recycled and agricultural-residue fibre inputs according to source and verification status. • Conduct a supplier risk assessment using a supplied questionnaire and risk matrix. • Verify supporting records for selected fibre	Guide students to: • Classify virgin, recycled and agricultural-residue fibre inputs according to source and verification status. • Conduct a supplier risk assessment using a supplied questionnaire and risk matrix. • Verify supporting records for selected fibre inputs and decide whether to approve, reject or conditionally accept the supplier. • Prepare a responsible-sourcing and risk-control plan for unverified or controversial fibre sources.	timber or fibre samples, tags, barcode or QR scanner, RFID demonstration kit, chain-of-custody forms, computer.

	6.6 Explain the process of supplier assessment and approval in a fibre procurement system and the specific traceability challenges associated with recycled fibre and agricultural residue inputs in the Nigerian paper and paper products industry. 6.7 Explain management approaches to, the related concept.	- Explain the process of supplier assessment and approval in a fibre procurement system and the specific traceability challenges associated with recycled fibre and agricultural residue inputs in the Nigerian paper and paper products industry. - Explain management approaches to, the related concept.		inputs and decide whether to approve, reject or conditionally accept the supplier. Prepare a responsible-sourcing and risk-control plan for unverified or controversial fibre sources.		
GENERAL OBJECTIVE 7.0: Know traceability record keeping, auditing, and reporting practices in paper and paper products operations						
13-15	7.1 Explain the importance of accurate and complete record keeping in maintaining a credible traceability system in a paper and paper products. 7.2 Explain the types of	- Explain the importance of accurate and complete record keeping in maintaining a credible traceability system in a paper and paper products. - Explain the types of records required in a	Traceability standards, chain-of-custody forms, barcode and RFID guides, audit	Maintain receiving, production, stock and dispatch records for a simulated traceability system.	Guide students to: - Maintain receiving, production, stock and dispatch records for a simulated traceability system. - Conduct a mock	Timber or fibre samples, tags, barcode or QR scanner, RFID demonstration kit, chain-of-custody forms, computer.

	records required in a timber and fibre traceability system and the principles of internal auditing as applied to traceability systems. 7.3 Describe the process and requirements of external or third-party traceability audits. 7.4 Explain the requirements for traceability reporting to regulatory authorities, certification bodies, and customers. 7.5 Describe common non-conformances in timber and fibre traceability systems. 7.6 Explain appropriate corrective and preventive actions for, the related concept and the simulated internal traceability audit using a provided audit checklist; document findings.	timber and fibre traceability system and the principles of internal auditing as applied to traceability systems. • Describe the process and requirements of external or third-party traceability audits. • Explain the requirements for traceability reporting to regulatory authorities, certification bodies, and customers. • Describe common non-conformances in timber and fibre traceability systems. • Explain appropriate corrective and preventive actions for, the related concept and the simulated internal traceability audit using a provided audit checklist; document findings.	templates, supply-chain diagrams, computer, projector, internet resources.	• Conduct a mock internal traceability audit using an approved audit checklist. • Perform a mass-balance or volume-reconciliation check on supplied records. • Prepare an audit report, non-conformity statement and corrective-and-preventive action plan.	internal traceability audit using an approved audit checklist. • Perform a mass-balance or volume-reconciliation check on supplied records. • Prepare an audit report, non-conformity statement and corrective-and-preventive action plan.	
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COURSE ASSESSMENT

Coursework:	10%
Tests:	10%
Practical:	40%
Examination:	40%
Total:	100%



ADVANCED PULPING TECHNOLOGY

COURSE TITLE: ADVANCED PULPING TECHNOLOGY	COURSE CODE: PPP 416	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR II SEMESTER I	PRE-REQUISITE: NIL	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to provide students with advanced knowledge and practical competencies in modern pulping technologies, pulp quality improvement, process optimization, environmental sustainability, and industrial pulp production systems.		
GENERAL OBJECTIVES : On completion of this course, the students should be able to: 1.0 Understand modern pulping processes and technologies. 2.0 Know pulp raw materials, fibre characteristics and paper properties of various fibrous raw materials. 3.0 Understand pulp bleaching, purification, finishing and quality improvement techniques for process control and optimization in pulping operations. 4.0 Understand process control and optimization in pulping operations 5.0 Understand various pulping processes and their principles of operation. 6.0 Understand pulp production in the laboratory. 7.0 Understand environmental sustainability in pulp production		

PROGRAMME: HIGHER NATIONAL DIPLOMA (HND) IN PULP AND PAPER MAKING						
COURSE TITLE: ADVANCED PULPING TECHNOLOGY				COURSE CODE: PPP 416		CONTACT HOURS: 4 HOURS/WEEK
				CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK
YEAR II		SEMESTER I		PRE-REQUISITE:		PRACTICAL: 3 HOURS/WEEK
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to provide students with advanced knowledge and practical competencies in modern pulping technologies, pulp quality improvement, process optimization, environmental sustainability, and industrial pulp production systems.						
GENERAL OBJECTIVE 1.0: Understand modern pulping processes and technologies.						
Week	THEORETICAL			PRACTICAL CONTENT		
	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1-3	1.1 Explain the historical development of pulping technology. 1.2 Explain principles of pulp production. 1.3 Describe mechanical, chemical and semi-chemical pulping processes. 1.4 Explain thermomechanical pulping (TMP) and chemi-thermomechanical pulping (CTMP). 1.5 Explain industrial applications of	- Explain the historical development of pulping technology. - Explain principles of pulp production. - Describe mechanical, chemical and semi-chemical pulping processes. - Explain thermomechanical pulping (TMP) and chemi-thermomechanical pulping (CTMP). - Explain industrial applications of various	Charts, Multimedia a Projector, Textbooks Industrial reports Journals	- Identify major pulping equipment used in industries. - Compare different pulping methods. - Perform fibre refining operations.	Guide students to: - Identify major pulping equipment used in industries. - Compare different pulping methods. - Perform fibre refining operations.	Digester, Industrial manuals, Fibre samples, Wood chips, Refiner, Pulp samples, Weighing balance, amples

	various pulping technologies.	pulping technologies.				
GENERAL OBJECTIVE 2.0: Know pulp raw materials, fibre characteristics and paper properties of various fibrous raw materials.						
4-5	2.1 Describe sources of pulp raw materials. 2.2 Explain fibre morphology and anatomy. 2.3 Explain physical and chemical properties of fibres. 2.4 Explain hardwood and softwood. 2.5 Describe pulping and paper characteristics of, the related concept.	- Describe sources of pulp raw materials. - Explain fibre morphology and anatomy. - Explain physical and chemical properties of fibres. - Explain hardwood and softwood. - Describe pulping and paper characteristics of, the related concept.	pulping textbooks, TAPPI standards, process-flow diagrams, liquor-chemistry charts, equipment manuals, computer, projector, internet resources.	- Identify fibre raw materials. - Examine fibre structures microscopically. - Determine fibre characteristics. - Identify materials for pulping.	Guide students to: - Identify fibre raw materials. - Examine fibre structures microscopically. - Determine fibre characteristics. - Identify materials for pulping.	fibre samples, chipper or sample chips, digester or autoclave, refiners, screens, laboratory glassware, chemicals, balance, PPE.
GENERAL OBJECTIVE 3.0: Understand pulp bleaching, purification, finishing and quality improvement techniques for process control and optimization in pulping operations						
6-7	3.1 Outline principles and objectives of pulp bleaching. 3.2 Explain Elemental Chlorine-free (ECF) and Total Chlorine-free (TCF) bleaching systems.	- Explain principles and objectives of pulp bleaching. - Explain Elemental Chlorine-free (ECF) and Total Chlorine-free (TCF) bleaching systems.	pulping textbooks, TAPPI standards, process-flow diagrams, liquor-	- Perform carry out pulp bleaching operations. - Measure pulp brightness.	Guide students to: - Perform carry out pulp bleaching operations. - Measure pulp brightness. - Conduct pulp	fibre samples, chipper or sample chips, digester or autoclave, refiners, screens, laboratory glassware,

	3.3 Explain pulp quality improvement techniques. 3.4 Explain the pulp purification processes washing and cleaning and the aims of pulp purification bleaching and finishing. 3.5 Describe the various bleaching processes. 3.6 Explain pulp finishing processes e.g lap formation, pressing, drying types and baling. 3.7 Evaluate purification, bleaching and finishing of pulp.	• Explain pulp quality improvement techniques. • Explain the pulp purification processes washing and cleaning and the aims of pulp purification bleaching and finishing. • Describe the various bleaching processes. • Explain pulp finishing processes e.g lap formation, pressing, drying types and baling. • Evaluate purification, bleaching and finishing of pulp.	chemistry charts, equipment manuals, computer, projector, internet resources.	• Conduct pulp quality assessment., Purify, bleach and finish pulp. • Prepare a concise illustrated summary of principles and objectives of pulp bleaching from supplied technical information.	quality assessment., Purify, bleach and finish pulp. • Prepare a concise illustrated summary of principles and objectives of pulp bleaching from supplied technical information.	chemicals, balance, PPE.
GENERAL OBJECTIVE: 4.0 Understand process control and optimization in pulping operations						
8-9	4.1 Explain process control systems in pulping operations. 4.2 Explain optimization techniques in pulp production. 4.3 Explain key process parameters affecting pulp quality and yield. 4.4 Explain optimization	• Explain process control systems in pulping operations. • Explain optimization techniques in pulp production. • Explain key process parameters affecting pulp quality and yield. • Explain optimization strategies to enhance	pulping textbooks, TAPPI standards, process-flow diagrams, liquor-chemistry charts, equipment	• Measure temperature , pressure, cooking time, and chemical charge during a pulping process. • Demonstrate	Guide students to: • Measure temperature, pressure, cooking time, and chemical charge during a pulping process. • Demonstrate process control systems in	fibre samples, chipper or sample chips, digester or autoclave, refiners, screens, laboratory glassware, chemicals, balance, PPE.

	strategies to enhance pulping performance and productivity.	pulping performance and productivity.	manuals, computer, projector, internet resources.	e process control systems in pulping operations through an assigned practical exercise. • Demonstrate optimization techniques in pulp production through an assigned practical exercise. • Demonstrate key process parameters affecting pulp quality and yield through an assigned practical exercise.	pulping operations through an assigned practical exercise. • Demonstrate optimization techniques in pulp production through an assigned practical exercise. • Demonstrate key process parameters affecting pulp quality and yield through an assigned practical exercise.	
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GENERAL OBJECTIVE 5.0: Understand various pulping processes and their principles of operation.						
10-11	5.1 Describe the general pulp mills layout. 5.2 Explain the methods of pulpwood and chip mensuration. 5.3 Describe the process stages of preparing wood for pulping viz log debarking, log splitting, chipping, screening and chip washing. 5.4 Explain the importance of chip size and chip quality on pulp properties. 5.5 Explain chip recovery. 5.6 Explain the general principles of pulping. 5.7 Describe the various pulping processes e.g. mechanical, semi-chemical and chemical. 5.8 Explain mechanical pulping processes. 5.9 Describe the stone ground wood pulping (SGW). 5.10 Explain the	- Describe the general pulp mills layout. - Explain the methods of pulpwood and chip mensuration. - Describe the process stages of preparing wood for pulping viz log debarking, log splitting, chipping, screening and chip washing. - Explain the importance of chip size and chip quality on pulp properties. - Explain chip recovery. - Explain the general principles of pulping. - Describe the various pulping processes e.g. mechanical, semi-chemical and chemical. - Explain mechanical pulping processes. - Describe the stone ground wood pulping (SGW).	Bleaching charts Multimedia resources Quality manuals Projector, Marker Marker board	- Conduct laboratory mechanical pulping using a blender/refiner on wood chips or non-wood fibres. - Perform a simple soda pulping experiment on agricultural residues (e.g., bagasse, straw). - Compare pulp yield from mechanical and chemical pulping processes. - Examine	Guide students to: - Conduct laboratory mechanical pulping using a blender/refiner on wood chips or non-wood fibres. - Perform a simple soda pulping experiment on agricultural residues (e.g., bagasse, straw). - Compare pulp yield from mechanical and chemical pulping processes. - Examine fibres from different pulping methods under a microscope. - Determine the Kappa number of a pulp sample. - Conduct a comparative study of Kraft,	Wood chips/non-wood fibres, laboratory refiner or blender, Weighing balance, Water supply Digestion vessel, Hot plate, Sodium hydroxide (NaOH), Bagasse/straw, Thermometer, PPE Fibre raw materials, Stopwatch, Pulp testing sheets Drying oven, Beakers Pulp samples, Potassium permanganate, sulfuric acid, Burette, Conical flask,

	operational principles, types of grinders, grinding variable, pulp qualities and uses of the process in 5.9 above. 5.11 Describe refiner mechanical pulping (RMP), thermomechanical pulping (TMP), chemi mechanical pulping (CMP) processes. 5.12 Describe various pre refiner treatment e.g. chip soaking and steam, cal addition before or at refiner. 5.13 Outline the properties and uses of pulp. 5.14 Describe semi-chemical pulping processes e.g. Acid sulphite, bisulphite, semi chemical processes. 5.15 Describe the neutral sulphite chemical process	• Explain the operational principles, types of grinders, grinding variable, pulp qualities. • Describe refiner mechanical pulping (RMP), thermomechanical pulping (TMP), chemi mechanical pulping (CMP) processes. • Describe various pre refiner treatment e.g. chip soaking and steam, cal addition before or at refiner. • Outline the properties and uses of pulp. • Describe semi-chemical pulping processes e.g. Acid sulphite, bisulphite, semi chemical processes. • Describe the neutral sulphite chemical process (NSSC). • Outline the chemical composition of liquor, and pulp properties		fibres from different pulping methods under a microscope. • Determine the Kappa number of a pulp sample. • Conduct a comparative study of Kraft, Sulphite, Mechanical, and Semi-chemical pulps.	Sulphite, Mechanical, and Semi-chemical pulps.	
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	(NSSC). 5.16 Outline the chemical composition of liquor, and pulp properties and uses. 5.17 Describe various chemical pulping processes: sulphite, soda, kraft (Sulphate). 5.18 Describe the sulphite pulping process including mill preparations of the pulping liquor, reaction in the digester, cooking variables. 5.19 Explain the properties and uses of sulphite pulps. 5.20 Describe recovery processes and objectives, and chemical recovery processes in the sulphite mill. 5.21 Describe soda pulping process. 5.22 Describe sulphate (Kraft) pulping process.	and uses. • Describe various chemical pulping processes: sulphite, soda, kraft (Sulphate). • Describe the sulphite pulping process including mill preparations of the pulping liquor, reaction in the digester, cooking variables. • Explain the properties and uses of sulphite pulps. • Describe recovery processes and objectives, and chemical recovery processes in the sulphite mill. • Describe soda pulping process. • Describe sulphate (Kraft) pulping process. • Explain the following terms used in the sulphate pulping processes:- total				
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	5.23 Explain the following terms used in the sulphate pulping processes:- total chemical, total alkali, active alkali, effective alkali, causticity sulphidity. 5.24 Describe the continous digestion process for the chemical sulphidity. 5.25 Describe the following new trends and developments of the chemical pulping processes — Multi stage pulping, introduction to authraquione (AQ).	chemical, total alkali, active alkali, effective alkali, causticity sulphidity. - Describe the continous digestion process for the chemical sulphidity. - Describe the following new trends and developments of the chemical pulping processes — Multi stage pulping, introduction to authraquione (AQ).				
GENERAL OBJECTIVE 6.0 Understand pulp production in the laboratory.						
12-13	6.1 Explain pulping liquor. 6.2 Describe mill manufacture of chlorine, sodium hydroxide, sodium hypochlorite and chlorine dioxide. 6.3 Describe water treatment process and	- Discuss pulping liquor. - Discuss mill manufacture of chlorine, sodium hydroxide, sodium hypochlorite and chlorine dioxide. - Explain water treatment process and	Charts, multimedia a projector, textbooks industrial reports, journals	- Prepare pulp samples in the spront laboratory refiner. - Produce chemical pulp using the	Guide students to: - Prepare pulp samples in the spront laboratory refiner. - Produce chemical pulp using the autoclave. - Identify ground wood pulp and	Pulp digester, chemicals (sodium hydroxide, sodium hypochlorite and chlorine dioxide), autoclave. Kappa number,

	steam generation. 6.4 Explain pulp samples in the spront laboratory refiner. 6.5 Describe pulp using the autoclave. 6.6 Explain ground wood pulp and chemical pulp by tests. 6.7 Explain chlorine number, kappa number, copper number, and permanganate (KmnO ₄) number of pulp.	steam generation. - Describe pulp samples in the spront laboratory refiner. - Explain pulp using the autoclave. - Describe ground wood pulp and chemical pulp by tests. - Discuss and determine chlorine number, kappa number, copper number, and permanganate (KmnO₄) number of pulp.		autoclave. - Identify ground wood pulp and chemical pulp by tests. - Determine chlorine number, kappa number, copper number, and permanganate (KmnO₄) number of pulp.	chemical pulp by tests. Determine chlorine number, kappa number, copper number, and permanganate (KmnO₄) number of pulp.	Laboratory coats
GENERAL OBJECTIVE 7.0: Understand environmental sustainability in pulp production						
14-15	1.1 Explain Industry. 1.2 Explain technologies in pulp manufacturing. 1.3 Explain digital process monitoring systems. 1.4 Explain automation, AI, digital twins and	- Explain Industry. - Explain technologies in pulp manufacturing. - Explain digital process monitoring systems. - Explain automation, AI, digital twins and	pulping textbooks, TAPPI standards, process-flow diagrams, liquor-chemistry	- Use a digital process-monitoring dashboard or simulator to observe key pulping variables and alarms. - Analyse supplied	Guide students to: - Use a digital process-monitoring dashboard or simulator to observe key pulping variables and alarms. - Analyse supplied time-series data for temperature, pressure,	fibre samples, chipper or sample chips, digester or autoclave, refiners, screens, laboratory glassware, chemicals,

	smart manufacturing systems.	smart manufacturing systems.	charts, equipment manuals, computer, projector, internet resources.	time-series data for temperature, pressure, chemical charge, yield and energy consumption. • Recommend control actions for identified process deviations and predict their effect on pulp quality. • Develop a simple concept model for an automated, AI-assisted or digital-twin pulping operation.	chemical charge, yield and energy consumption. • Recommend control actions for identified process deviations and predict their effect on pulp quality. • Develop a simple concept model for an automated, AI-assisted or digital-twin pulping operation.	balance, PPE.
COURSE ASSESSMENT						
COURSE WORK: 10% TESTS/ASSIGNMENTS: 10% PRACTICAL: 40% EXAMINATION: 40% TOTAL: 100%						

SUSTAINABLE PACKAGING DESIGN AND INNOVATION

PROGRAMME: HIGH NATIONAL DIPLOMA IN PAPER AND PAPER PRODUCTS TECHNOLOGY			
COURSE TITLE: SUSTAINABLE PACKAGING DESIGN AND INNOVATION		COURSE CODE: PPP 417	CONTACT HOURS: 4 HOURS/WEEK
		CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR II	SEMESTER I	PRE-REQUISITE: NIL	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to enable students with knowledge and skills of sustainable packaging principles, paper and board materials used in packaging.			
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the functions, materials, and sustainability challenges of modern packaging. 2.0 Know the paper and board materials used in packaging and their performance characteristics. 3.0 Know structural packaging design principles to paper-based packaging development. 4.0 Understand innovation trends in sustainable paper-based packaging.			



PROGRAMME: HIGH NATIONAL DIPLOMA IN PAPER AND PAPER PRODUCTS TECHNOLOGY						
COURSE TITLE: SUSTAINABLE PACKAGING DESIGN AND INNOVATION			COURSE CODE: PPP 417		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR II	SEMESTER I		PRE-REQUISITE: NIL		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to enable students with knowledge and skills of sustainable packaging principles, paper and board materials used in packaging.						
GENERAL OBJECTIVE 1.0: Understand the functions, materials, and sustainability challenges of modern packaging						
Week	THEORETICAL			PRACTICAL CONTENT		
	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1-2	1.1 Explain the primary functions of packaging 1.2 Explain the influence material selection and package design. 1.3 Explain the major categories of packaging materials and environmental performance 1.4 Explain in terms of resource use, recyclability, biodegradability, and carbon footprint.	- Explain the primary functions of packaging - Explain the influence material selection and package design. - Explain the major categories of packaging materials and environmental	Packaging standards, package samples, structural-design guides, CAD illustrations, performance-test specifications, computer, projector, internet resources.	- Examine a set of assigned packaging samples. - Classify each by material type. - Prepare a concise illustrated summary of the primary functions of packaging and how	Guide students to: - Examine a set of assigned packaging samples. - Classify each by material type. - Prepare a concise illustrated summary of the primary functions of packaging and how from supplied technical information - Apply influence material selection and package design to an assigned practical task	Paperboard and corrugated samples, cutting and creasing tools, CAD software, rulers, adhesives, compression-test equipment, PPE.

	1.5 Describe sustainable packaging and the key sustainability criteria. 1.6 Explain the global and Nigerian packaging market landscape and the shift from plastic to paper-based packaging. 1.7 Explain the concepts of packaging waste, littering, and marine pollution	performance • Explain in terms of resource use, recyclability, biodegradability, and carbon footprint. • Describe sustainable packaging and the key sustainability criteria. • Explain the global and Nigerian packaging market landscape and the shift from plastic to paper-based packaging. • Explain the concepts of packaging waste, littering, and marine pollution		from supplied technical information. • Apply influence material selection and package design to an assigned practical task and document the outcome.	and document the outcome.	
GENERAL OBJECTIVE 2.0: Know the paper and board materials used in packaging and their performance characteristics						

3-5	2.1 Explain the major paper and board grades used in packaging and the key quality properties of, the related concept. 2.2 Explain the structural performance requirements for corrugated board packaging. 2.3 Describe the barrier properties required for food and beverage packaging 2.4 Explain are achieved in paper-based packaging through coating, lamination, and surface treatment. 2.5 Describe the properties and applications of moulded fibre packaging and the raw material and manufacturing requirements. 2.6 Explain recyclability in paper-based	• Explain the major paper and board grades used in packaging and the key quality properties of, the related concept. • Explain the structural performance requirements for corrugated board packaging. • Describe the barrier properties required for food and beverage packaging • Explain are achieved in paper-based packaging through coating, lamination, and surface treatment.	Packaging standards, package samples, structural-design guides, CAD illustrations, performance-test specifications, computer, projector, internet resources.	• Test the ECT and ring crush strength of assigned corrugated board and linerboard samples. • Compare results against standard corrugated packaging specifications. • Conduct a water resistance test (Cobb test) and a grease resistance test on assigned coated and uncoated packaging samples; compare results and	Guide students to: • Test the ECT and ring crush strength of assigned corrugated board and linerboard samples. • Compare results against standard corrugated packaging specifications. • Conduct a water resistance test (Cobb test) and a grease resistance test on assigned coated and uncoated packaging samples; compare results and relate to food contact packaging requirements. • Demonstrate or model the major paper and board grades used in packaging and the key quality properties of, the related concept through an assigned practical exercise.	Paperboard and corrugated samples, cutting and creasing tools, CAD software, rulers, adhesives, compression-test equipment, PPE.
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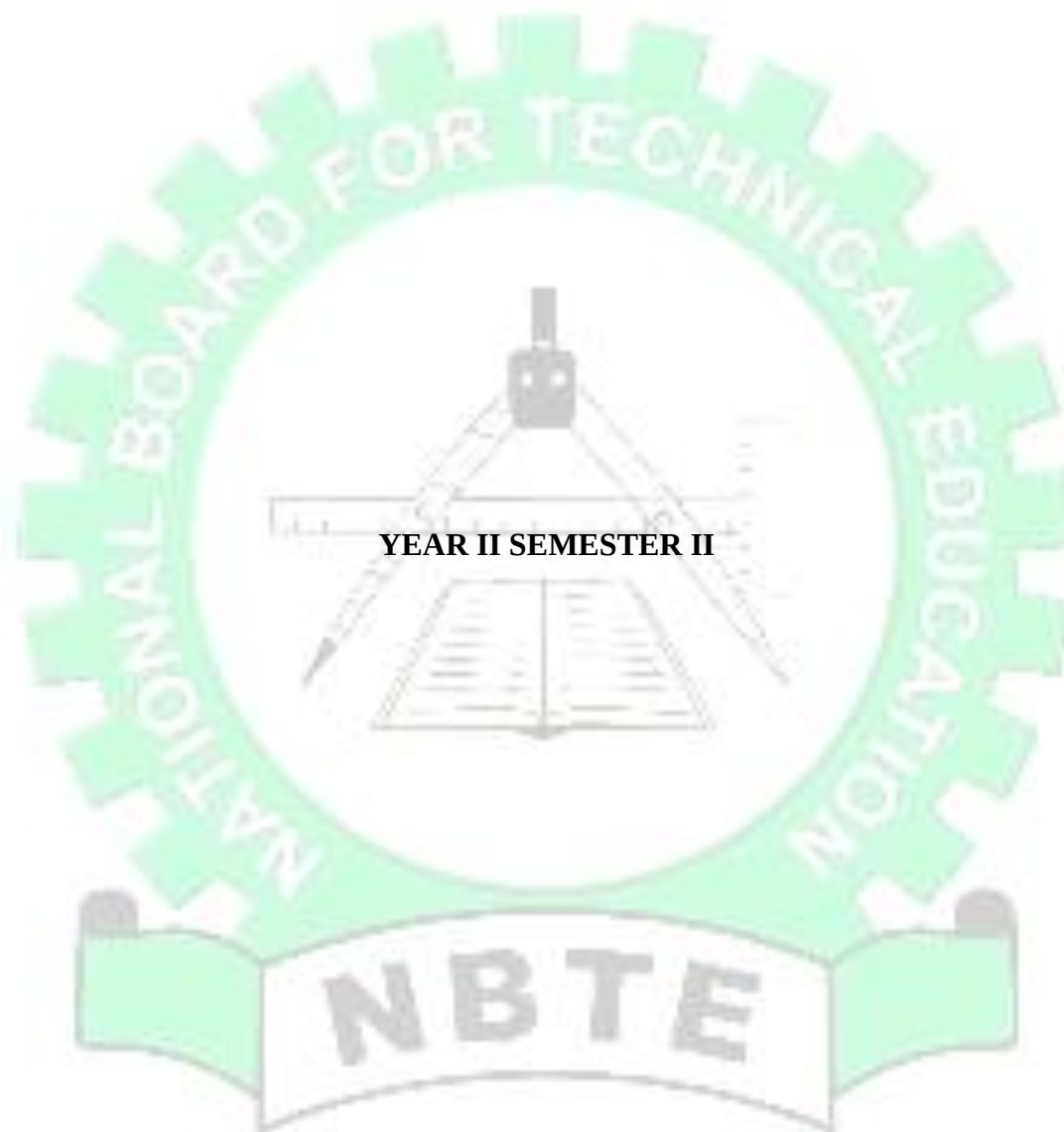
	packaging. 2.7 Evaluate the properties and applications of recycled content paperboard and the quality trade-offs involved in increasing recycled fibre content in packaging board.	- Describe the properties and applications of moulded fibre packaging and the raw material and manufacturing requirements. - Explain recyclability in paper-based packaging. - Evaluate the properties and applications of recycled content paperboard and the quality trade-offs involved in increasing recycled fibre content in packaging board.		relate to food contact packaging requirements. Demonstrate or model the major paper and board grades used in packaging and the key quality properties of, the related concept through an assigned practical exercise.		
GENERAL OBJECTIVE 3.0: Know structural packaging design principles to paper-based packaging development						
6-9	3.1 Explain the principles of structural packaging design.	Explain the principles of structural	Packaging standards, package samples,	Perform carryout Flute identification	Guide students to: Perform carryout Flute identification exercise,	Paperboard and corrugated samples, cutting

	3.2 Explain the standard corrugated board flute profiles and the performance characteristics and preferred applications of each. 3.3 Describe the standard corrugated box styles. 3.4 Explain when each style is selected for a given product and distribution requirement. 3.5 Explain the principles of carton and folding box design for consumer packaging. 3.6 Explain the role of graphics, printing, and surface finishing in paper packaging 3.7 Explain interact with structural design.	packaging design. • Explain the standard corrugated board flute profiles and the performance characteristics and preferred applications of each. • Describe the standard corrugated box styles. • Explain when each style is selected for a given product and distribution requirement. • Explain the principles of carton and folding box design for consumer packaging. • Explain the role of	structural-design guides, CAD illustrations, performance-test specifications, computer, projector, internet resources.	exercise, Supervise caliper and ECT testing. • Assemble box and carton; base on style identification and quality evaluation., structural layout design exercise for carton., Watch a video on carton assembly. • Apply the principles of structural packaging design to an assigned practical task and document the outcome. • Demonstrate or model the standard corrugated	Supervise caliper and ECT testing. • Assemble box and carton; base on style identification and quality evaluation., structural layout design exercise for carton., Watch a video on carton assembly. • Apply the principles of structural packaging design to an assigned practical task and document the outcome. • Demonstrate or model the standard corrugated board flute profiles and the performance characteristics and preferred applications of each through an assigned practical exercise.	and creasing tools, CAD software, rulers, adhesives, compression-test equipment, PPE.
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		graphics, printing, and surface finishing in paper packaging • Explain interact with structural design.		board flute profiles and the performance characteristics and preferred applications of each through an assigned practical exercise.		
GENERAL OBJECTIVE 4.0: Understand innovation trends in sustainable paper-based packaging						
8	4.1 Outline current innovation trends in sustainable paper-based packaging. 4.2 Explain active packaging. 4.3 Describe how active technologies are being incorporated into paper-based packaging systems. 4.4 Explain how digital technologies are integrated into paper-based packaging and the principles of bio-based and	• Explain current innovation trends in sustainable paper-based packaging. • Explain active packaging. • Describe how active technologies are being incorporated into paper-based	packaging standards, package samples, structural-design guides, CAD illustrations, performance-test specifications, computer, projector, internet resources.	• Classify active, smart, bio-based, biodegradable and compostable paper-packaging samples. • Design a simple sustainable packaging prototype incorporating an active	Guide students to: • Classify active, smart, bio-based, biodegradable and compostable paper-packaging samples. • Design a simple sustainable packaging prototype incorporating an active or smart feature. • Evaluate the prototype for functionality, material efficiency, recyclability and suitability for Nigerian market conditions	paperboard and corrugated samples, cutting and creasing tools, CAD software, rulers, adhesives, compression-test equipment, PPE.

	compostable packaging. 4.5 Explain the difference between biodegradable, compostable, and home-compostable certifications. 4.6 Explain the commercial readiness, market availability, and suitability for Nigerian market conditions of the three. 4.7 Evaluate assigned sustainable packaging innovations.	packaging systems. • Explain how digital technologies are integrated into paper-based packaging and the principles of bio-based and compostable packaging. • Explain the difference between biodegradable, compostable, and home-compostable certifications. • Explain the commercial readiness, market availability, and suitability for Nigerian market		or smart feature. • Evaluate the prototype for functionality, material efficiency, recyclability and suitability for Nigerian market conditions. • Compare product claims with relevant biodegradable and compostable certification requirements.	
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		conditions of the three. Evaluate assigned sustainable packaging innovations.				
COURSE ASSESSMENT						
COURSE WORK: 10% TESTS/ASSIGNMENTS: 10% PRACTICAL: 40% EXAMINATION: 40% TOTAL: 100%						



YEAR II SEMESTER II

ENVIRONMENTAL MANAGEMENT IN PULP AND PAPER

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)		
COURSE TITLE: ENVIRONMENTAL MANAGEMENT IN PULP AND PAPER	COURSE CODE: PPP 421	CONTACT HOURS: 3 HOURS/WEEK
	CREDIT UNIT: 3	THEORETICAL: 3 HOURS/WEEK
YEAR II SEMESTER II	PRE-REQUISITE:	PRACTICAL: 2 HOURS/WEEK
GOAL: This course is designed to equip students with the knowledge and skills to manage environmental impacts of pulp and paper production.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand how pulp and paper processes affect air, water, soil, and ecosystems; 2.0 Know technologies to reduce emissions, effluents, and solid waste; 3.0 Understand recycling, energy efficiency, and eco-friendly raw materials into production systems; 4.0 Know international standards (ISO, OSHA, environmental laws) in pulp and paper operations; 5.0 Understand biotechnological methods, renewable energy integration, and circular economy approaches.		

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)						
COURSE TITLE: ENVIRONMENTAL MANAGEMENT IN PULP AND PAPER				COURSE CODE: PPP 421		CONTACT HOURS: 3 HOURS/WEEK
				CREDIT UNIT: 3		THEORETICAL: 1 HOUR/WEEK
YEAR II	SEMESTER II			PRE-REQUISITE:		PRACTICAL: 2 HOURS/WEEK
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: GOAL: This course is designed to equip students with the knowledge skills to manage environmental impacts of pulp and paper production.						
GENERAL OBJECTIVE 1.0: Understand the effects of pulp and paper process in ecosystems.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1-3	1.1 Outline air emissions and measurement of particulate matter. 1.2 Explain water effluents and soil contamination. 1.3 Describe the sampling and testing of wastewater quality parameters. 1.4 Explain the impacts on biodiversity and ecological balance. 1.5 Describe the principles of adsorbable organic	- Outline air emissions and measurement of particulate matter. - Explain water effluents and soil contamination. - Describe the sampling and testing of wastewater quality parameters. - Explain the impacts on biodiversity and ecological balance. - Describe the principles of adsorbable organic halides analysis - Outline techniques for monitoring Total Reduced	White Board, Marker, charts, projector, textbooks, etc.	- Measure particulate matter in air samples using standard monitoring equipment. - Collect water effluent and soil samples using standard sampling procedures. - Determine wastewater quality parameters using standard laboratory methods. - Assess environmental impacts using biodiversity and ecosystem data.	Guide students to: - Measure particulate matter in air samples using standard monitoring equipment. - Collect water effluent and soil samples using standard sampling procedures. - Determine	water and effluent samples, sampling containers, pH, DO and conductivity meters, audit forms, PPE.

	halides analysis 1.6 Outline techniques for monitoring Total Reduced Sulphur (TRS) gases.	Sulphur (TRS) gases.		• Perform adsorbable organic halides analysis using standard laboratory equipment. • Monitor Total Reduced Sulphur gases using appropriate measuring instruments.	wastewater quality parameters using standard laboratory methods. • Assess environmental impacts using biodiversity and ecosystem data. • Perform adsorbable organic halides analysis using standard laboratory equipment. • Monitor Total Reduced Sulphur gases using appropriate measuring instruments.	
GENERAL OBJECTIVE 2.0: Know technologies to reduce emissions, effluents, and solid waste.						
4-5	1.1 Explain air emission reduction	• Explain air emission reduction	White Board, Marker,	• Apply air emission reduction	• Apply air emission reduction	water and effluent samples,

	methods. 1.2 Explain water effluent treatment methods. 1.3 Describe solid waste management practices. 1.4 Explain cleaner production principles. 1.5 Explain environmental compliance and sustainability requirements. 1.6 □ Describe recycling, composting, and energy recovery methods.	methods. • Explain water effluent treatment methods. • Describe solid waste management practices. • Explain cleaner production principles. • Explain environmental compliance and sustainability requirements. • Describe recycling, composting, and energy recovery methods.	charts, projector, textbooks, etc.	techniques. • Operate water effluent treatment processes. • Implement solid waste management procedures. • Apply cleaner production practices. • Evaluate compliance with environmental requirements. • Demonstrate recycling, composting, and energy recovery methods	techniques. • Operate water effluent treatment processes. • Implement solid waste management procedures. • Apply cleaner production practices. • Evaluate compliance with environmental requirements. • Demonstrate recycling, composting, and energy recovery methods	sampling containers, pH, DO and conductivity meters, audit forms, PPE.
GENERAL OBJECTIVE 3.0: Understand recycling, energy efficiency, and eco-friendly raw materials into production systems.						
6-7	3.1 Explain recycling	• Discuss recycling methods	White	• Produce recycled paper	Guide students	Water and

	methods. 3.2 Explain waste paper collection, de-inking and fiber recovery processes. 3.3 Explain energy efficiency. 3.4 Describe eco-friendly raw materials. 3.5 Explain how to integrate sustainable practices. 3.6 Explain environmental benefits of, the related concept.	using relevant examples, diagrams and illustrations. - Describe waste paper collection, de-inking and fiber recovery processes using relevant examples, diagrams and illustrations. - Discuss energy efficiency using relevant examples, diagrams and illustrations. - Explain eco-friendly raw materials with relevant examples, diagrams or case materials. - Describe how to integrate sustainable practices using relevant examples, diagrams and illustrations. - Discuss environmental benefits of, the related concept using relevant examples, diagrams and illustrations.	Board, Marker, charts, projector, textbooks, etc.	goods with reduced environmental footprint. - Conduct experiment with non-wood fibres (bamboo, bagasse, hemp) and biodegradable additives. - Use renewable raw materials into paper production. - Demonstrate recycling methods through an assigned practical exercise.	to: - Produce recycled paper goods with reduced environmental footprint. - Conduct experiment with non-wood fibres (bamboo, bagasse, hemp) and biodegradable additives. - Use renewable raw materials into paper production. - Demonstrate recycling methods through an assigned practical exercise.	effluent samples, sampling containers, pH, DO and conductivity meters, audit forms, PPE.
GENERAL OBJECTIVE: 4.0 Know international standards (ISO, OSHA, environmental laws) in pulp and paper operations						
8-9	4.1 Explain ISO standards. 4.2 Explain OSHA compliance. 4.3 Describe how to interpret environmental laws.	- Discuss ISO standards using relevant examples, diagrams and illustrations. - Describe OSHA compliance using relevant examples, diagrams and illustrations.	White Board, Marker, charts, projector, textbooks, etc.	- Interpret selected ISO, occupational-safety and environmental legal requirements applicable to a pulp and paper facility. - Conduct a mock	Guide students to: Interpret selected ISO, occupational-safety and environmental	water and effluent samples, sampling containers, pH, DO and conductivity

	4.4 Explain compliance audits.	• Explain how to interpret environmental laws with relevant examples, diagrams or case materials. • Discuss compliance audits using relevant examples, diagrams and illustrations.		environmental and occupational-safety compliance audit using a structured checklist. • Identify legal and standards-based non-conformities in supplied mill records or a simulated facility. • Prepare an audit report and prioritised compliance-improvement plan.	legal requirements applicable to a pulp and paper facility. • Conduct a mock environmental and occupational-safety compliance audit using a structured checklist. • Identify legal and standards-based non-conformities in supplied mill records or a simulated facility. • Prepare an audit report and prioritised compliance-improvement plan.	meters, audit forms, PPE.
GENERAL OBJECTIVE: 5.0: Understand biotechnological methods, renewable energy integration, and circular economy approaches.						
10-11	5.1 Explain biotechnological methods. 5.2 Describe biomass boilers, solar drying,	• Discuss biotechnological methods using relevant examples, diagrams and illustrations. • Discuss biomass boilers,	White Board, Marker, charts, projector,	• Use biotechnology to reduce chemical usage and pollution. • Conduct biomass boilers, solar drying,	Guide students to: • Use biotechnology to reduce chemical	water and effluent samples, sampling containers, pH,

	and cogeneration systems. 5.3 Describe waste valorisations and closed-loop systems. 5.4 Explain eco-efficiency. 5.5 Describe the Innovation of sustainable solutions.	solar drying, and cogeneration systems using relevant examples, diagrams and illustrations. • Discuss waste valorisations and closed-loop systems using relevant examples, diagrams and illustrations. • Discuss eco-efficiency using relevant examples, diagrams and illustrations. • Discuss the Innovation of sustainable solutions using relevant examples, diagrams and illustrations.	textbooks, etc.	and cogeneration systems. • Develop innovative, sustainable, and market-ready paper products. • Demonstrate biotechnological methods through an assigned practical exercise.	usage and pollution. • Conduct biomass boilers, solar drying, and cogeneration systems. • Develop innovative, sustainable, and market-ready paper products. • Demonstrate biotechnological methods through an assigned practical exercise.	DO and conductivity meters, audit forms, PPE.
COURSE ASSESSMENT: Course Work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

BUSINESS MANAGEMENT IN PULP AND PAPER

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)			
COURSE TITLE: BUSINESS MANAGEMENT IN PULP AND PAPER		COURSE CODE: PPP 422	CONTACT HOURS: 3 HOURS/WEEK
		CREDIT UNIT: 3	THEORETICAL: 1 HOUR/WEEK
YEAR II	SEMESTER II	PRE-REQUISITE: NIL	PRACTICAL: 2 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills of business management in pulp and paper.			
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the fundamentals of business management in the pulp and paper; 2.0 Know production planning and operational management principles in pulp and papermaking; 3.0 Know cost control and financial management practices in pulp and paper enterprises; 4.0 Understand marketing strategies and customer relationship management in the pulp and paper; 5.0 Know human resource and organisational management principles in pulp and paper enterprises; 6.0 Understand entrepreneurial and business development skills relevant to the pulp and paper.			

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)						
COURSE TITLE: BUSINESS MANAGEMENT IN PULP AND PAPER			COURSE CODE: PPP 422		CONTACT HOURS: 3 HOURS/WEEK	
			CREDIT UNIT: 2		THEORETICAL: 1 HOUR/WEEK	
YEAR II	SEMESTER II		PRE-REQUISITE:		PRACTICAL: 2 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is design to equip student knowledge and skill of business management in pulp and paper.						
GENERAL OBJECTIVE 1.0: Understand the fundamentals of business management in the pulp and paper industry						
Week	THEORETICAL CONTENT			PRACTICAL CONTENT		
	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1-3	1.1 Outline business management. 1.2 Explain business management relevance to the pulp and paper industry. 1.3 Explain the key functions of management as applied in a pulp and paper enterprise. 1.4 Explain the different forms of business ownership relevant to the pulp and paper industry	• Explain business management with relevant examples, diagrams or case materials. • Discuss business management relevance to the pulp and paper industry. • Describe the key functions of management as applied in a pulp and paper enterprise with relevant examples, diagrams or case materials. • Discuss the different forms of business	White Board, Marker, charts, projector, textbooks, etc.	• Develop an organisational chart for a typical pulp and paper enterprise and assign management functions to its departments. • Compare suitable forms of business ownership for an assigned pulp or paper enterprise. • Analyse a corporate-governance case and identify responsibilities, control gaps and ethical issues. • Prepare a concise	Guide students to: • Develop an organisational chart for a typical pulp and paper enterprise and assign management functions to its departments. • Compare suitable forms of business ownership for an assigned pulp or paper enterprise. • Analyse a corporate-governance case and identify responsibilities, control gaps and	Computer, Spreadsheet software, costing sheets, production data, market survey forms, business-plan templates.

	and the organisational structure of a typical pulp and paper mill. 1.5 Describe the roles and responsibilities of key departments of, the related concept. 1.6 Explain corporate governance and the importance of. 1.7 Discuss the criteria and evidence required in managing a pulp and paper enterprise responsibly.	ownership relevant to the pulp and paper industry and the organisational structure of a typical pulp and paper mill using relevant examples, diagrams and illustrations. • Explain the roles and responsibilities of key departments of, the related concept with relevant examples, diagrams or case materials. • Discuss corporate governance and the importance of using relevant examples, diagrams and illustrations. • Discuss the criteria and evidence required in managing a pulp and paper enterprise responsibly through case studies.		illustrated summary of business management from supplied technical information.	ethical issues. • Prepare a concise illustrated summary of business management from supplied technical information.	
GENERAL OBJECTIVE 2.0: Know production planning and operational management principles in pulp and paper making						
4-6	2.1 Explain production planning. 2.2 Explain importance	• Discuss production planning using relevant examples, diagrams and	White Board, Marker,	• Prepare a production plan and schedule for an assigned pulp or	Guide students to: • Prepare a production plan and schedule	Computer, Spreadsheet software,

	of. 2.3 Explain in ensuring efficient mill operations. 2.4 Describe the steps involved in production planning for a pulp and paper mill. 2.5 Explain the principles of operations management as applied to pulp and paper production. 2.6 Describe the role of inventory management in pulp and paper operations. 2.7 Explain the application of basic production management tools.	illustrations. • Discuss importance of using relevant examples, diagrams and illustrations. • Discuss in ensuring efficient mill operations using relevant examples, diagrams and illustrations. • Explain the steps involved in production planning for a pulp and paper mill with relevant examples, diagrams or case materials. • Discuss the principles of operations management as applied to pulp and paper production using relevant examples, diagrams and illustrations. • Explain the role of inventory management in pulp and paper operations with relevant examples, diagrams or case materials. • Discuss the application of basic production	charts, projector, textbooks, etc.	paper order. • Develop a basic material-requirement and inventory-control schedule for fibre, chemicals and finished products. • Use a flowchart, Gantt chart or spreadsheet to identify bottlenecks and improve mill operations. • Demonstrate or model production planning through an assigned practical exercise.	for an assigned pulp or paper order. • Develop a basic material-requirement and inventory-control schedule for fibre, chemicals and finished products. • Use a flowchart, Gantt chart or spreadsheet to identify bottlenecks and improve mill operations. • Demonstrate or model production planning through an assigned practical exercise.	costing sheets, production data, market survey forms, business-plan templates.
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		management tools using relevant examples, diagrams and illustrations.				
GENERAL OBJECTIVE 3.0: Know cost control and financial management practices in pulp and paper enterprises						
7-9	3.1 Outline the various types of costs in pulp and paper production 3.2 Explain the methods of cost estimation and costing in pulp and paper manufacturing. 3.3 Explain break-even analysis. 3.4 Describe how to determine and for minimum output required for profitability in a pulp or paper enterprise. 3.5 Explain the components of a basic financial statement. 3.6 Describe their relevance to mill management and budgeting as a	• Discuss the various types of costs in pulp and paper production • Describe the methods of cost estimation and costing in pulp and paper manufacturing. • Discuss break-even analysis. • Explain how to determine and for minimum output required for profitability in a pulp or paper enterprise. • Explain the components of a basic financial statement. • Describe their relevance to mill management and budgeting as a financial management tool. • Discuss the process of preparing an operational budget for a pulp and paper enterprise. • Discuss common financial management challenges in the pulp and paper	White Board, Marker, charts, projector, textbooks, etc.	• Classify production costs • Prepare a simple unit-cost statement for an assigned paper product. • Calculate break-even output, contribution margin and expected profit under alternative production scenarios. • Prepare an operating budget • Interpret a simplified income statement and statement of financial position. • Recommend feasible cost-reduction measures without compromising quality and safety.	Guide students to: • Classify production costs • Prepare a simple unit-cost statement for an assigned paper product. • Calculate break-even output, contribution margin and expected profit under alternative production scenarios. • Prepare an operating budget • Interpret a simplified income statement and statement of financial position. • Recommend feasible cost-reduction measures without compromising quality and safety.	Computer, Spreadsheet software, costing sheets, production data, market survey forms, business-plan templates.

	financial management tool. 3.7 Explain the process of preparing an operational budget for a pulp and paper enterprise. 3.8 Describe common financial management challenges in the pulp and paper industry and cost reduction strategies in the related concept.	industry and cost reduction strategies in the related concept.				
GENERAL OBJECTIVE 4.0: Understand marketing strategies and customer relationship management in the pulp and paper industry						
10-11	4.1 Explain the similarities, differences and selection criteria relating to marketing and the 4.2 Explain selling with examples relevant to pulp and paper products and the elements of the marketing mix: product, price, place, and promotion.	• Discuss the similarities, differences and selection criteria relating to marketing and the difference between. • Discuss selling with examples relevant to pulp and paper products and the elements of the marketing mix: product, price, place, and promotion using relevant examples, diagrams and illustrations. • Explain the application of	White Board, Marker, charts, projector, textbooks, etc.	• Perform segment a supplied market • Identify a target customer group for a selected pulp or paper product. • Develop an appropriate product, price, distribution and promotion strategy. • Prepare a simple customer-acquisition and customer-retention plan using	Guide students to: • Perform segment a supplied market • Identify a target customer group for a selected pulp or paper product. • Develop an appropriate product, price, distribution and promotion strategy. • Prepare a simple customer-	Computer, Spreadsheet software, costing sheets, production data, market survey forms, business-plan templates.

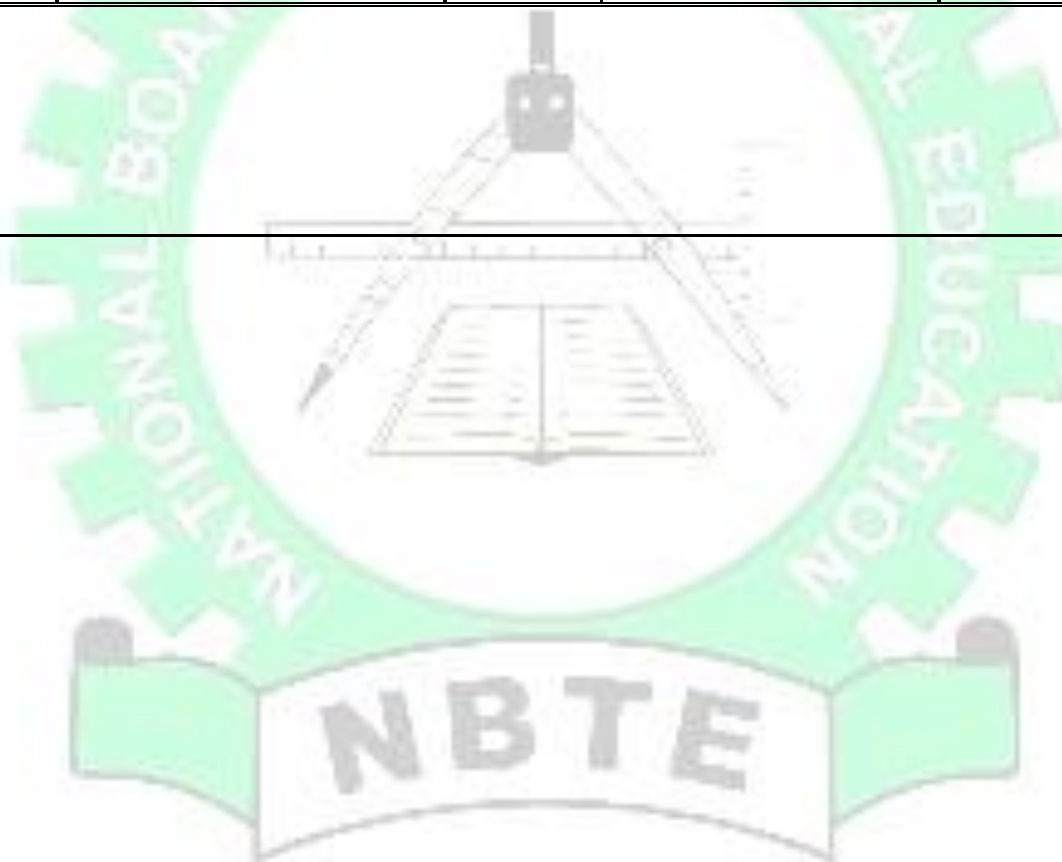
	4.3 Describe application of and to pulp and paper products. 4.4 Describe the application market segmentation, targeting, and positioning as tools for developing effective marketing strategies for pulp and paper products. 4.5 Describe the channels of distribution available for pulp and paper products and the principles of customer relationship management (CRM). 4.6 Explain how to retain customers and grow market share in the pulp and paper industry. 4.7 Describe the application current trends in the global pulp and paper market	and to pulp and paper products with relevant examples, diagrams or case materials. • Explain and discuss the application procedure for market segmentation, targeting, and positioning as tools for developing effective marketing strategies for pulp and paper products using relevant examples. • Explain the channels of distribution available for pulp and paper products and the principles of customer relationship management (CRM) with relevant examples, diagrams or case materials. • Discuss how to retain customers and grow market share in the pulp and paper industry using relevant examples, diagrams and illustrations. • Discuss the application procedure for current trends in the global pulp and paper market		CRM principles. • Present a concise marketing plan based on supplied market data. • Compare marketing and the difference between using specified criteria • Present the results in a table or chart.	acquisition and customer-retention plan using CRM principles. • Present a concise marketing plan based on supplied market data. • Compare marketing and the difference between using specified criteria • Present the results in a table or chart.	
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	4.8 Explain the development of a simple marketing plan for a pulp or paper product given relevant market data.	Describe the development of a simple marketing plan for a pulp or paper product given relevant market data using relevant examples.				
GENERAL OBJECTIVE 5.0: Know human resource and organisational management principles in pulp and paper enterprises						
12-13	5.1 Outline the role and functions of human resource management (HRM) in a pulp and paper enterprise. 5.2 Explain the processes of manpower planning, recruitment, selection, and placement as applied in a mill setting. 5.3 Explain the importance of staff training, development, and performance appraisal in improving productivity in pulp and paper operations. 5.4 Discuss the	- Explain the role and functions of human resource management (HRM) in a pulp and paper enterprise. - Discuss the processes of manpower planning, recruitment, selection, and placement as applied in a mill setting. - Discuss the importance of staff training, development, and performance appraisal in improving productivity in pulp and paper operations. - Discuss the application procedure for the principles of employee motivation - motivational theories are applied to workforce management in the industry and	White Board, Marker, charts, projector, textbooks, etc.	- Prepare a manpower plan and job description for selected positions in a pulp and paper mill. - Design a simple recruitment, induction, training and performance-appraisal process. - Role-play a grievance, conflict or labour-relations scenario and propose a fair resolution. - Assess how organisational culture and motivation affect productivity and safety compliance. - Prepare a concise illustrated summary of the role and functions of human resource	Guide students to: - Prepare a manpower plan and job description for selected positions in a pulp and paper mill. - Design a simple recruitment, induction, training and performance-appraisal process. - Role-play a grievance, conflict or labour-relations scenario and propose a fair resolution. - Assess how organisational culture and motivation affect productivity and safety compliance. - Prepare a concise illustrated summary of the role and	Computer, Spreadsheet Software, Costing Sheets, Production Data, Market Survey Forms, Business-Plan Templates.

	application procedures for the principles of employee motivation 5.5 Explain how motivational theories are applied to workforce management in the industry and organisational culture. 5.6 Explain influences productivity, safety compliance, and employee behaviour in a pulp and paper mill. 5.7 Explain the principles of conflict resolution, grievance handling, and labour relations in a pulp and paper enterprise.	organisational culture. • Discuss influences productivity, safety compliance, and employee behaviour in a pulp and paper mill. • Discuss the principles of conflict resolution, grievance handling, and labour relations in a pulp and paper enterprise through case studies.		management (HRM) in a pulp and paper enterprise from supplied technical information.	functions of human resource management (HRM) in a pulp and paper enterprise from supplied technical information.	
GENERAL OBJECTIVE 6.0: Understand entrepreneurial and business development skills relevant to the pulp and paper industry						
14-15	6.1 Describe entrepreneurship. 6.2 Explain the characteristics of a successful entrepreneur in the	• Explain entrepreneurship. • Discuss the characteristics of a successful entrepreneur in the pulp and paper industry. • Explain the process of	White Board, Marker, charts, projector, textbooks,	• Identify a viable business opportunity within the pulp, paper or paper-conversion value chain. • Conduct a preliminary	Guide students to: • Identify a viable business opportunity within the pulp, paper or paper-conversion value	computer, spreadsheet software, costing sheets, production data, market

	pulp and paper industry. 6.3 Describe the process of identifying and evaluating business opportunities in the pulp and paper value chain. 6.4 Explain the application procedure for steps involved in developing a business plan for a pulp and paper enterprise and the sources of business finance available to small and medium pulp and paper enterprises in Nigeria. 6.5 Describe the role of innovation and technology adoption in sustaining and growing a pulp and paper business. 6.6 Explain the legal and regulatory requirements for establishing and	identifying and evaluating business opportunities in the pulp and paper value chain with relevant examples, diagrams or case materials. • Discuss the application procedure for the steps involved in developing a business plan for a pulp and paper enterprise and the sources of business finance available to small and medium pulp and paper enterprises in Nigeria using relevant examples. • Explain the role of innovation and technology adoption in sustaining and growing a pulp and paper business with relevant examples, diagrams or case materials. • Discuss the legal and regulatory requirements for establishing and operating a pulp and paper enterprise in Nigeria using relevant examples, diagrams and illustrations. • Discuss a summary	etc.	market, technical, financial and regulatory feasibility assessment. • Prepare a concise business plan or feasibility report for the selected enterprise. • Pitch the proposed enterprise and respond to questions on finance, risk, innovation and sustainability. • Prepare a concise illustrated summary of entrepreneurship from supplied technical information.	chain. • Conduct a preliminary market, technical, financial and regulatory feasibility assessment. • Prepare a concise business plan or feasibility report for the selected enterprise. • Pitch the proposed enterprise and respond to questions on finance, risk, innovation and sustainability. • Prepare a concise illustrated summary of entrepreneurship from supplied technical information.	survey forms, business-plan templates.
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	operating a pulp and paper enterprise in Nigeria. 6.7 Describe a summary business plan or feasibility outline for a small-scale pulp or paper enterprise.	business plan or feasibility outline for a small-scale pulp or paper enterprise through case studies.				
COURSE ASSESSMENT: Course Work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						



INDUSTRY 4.0 APPLICATIONS IN PAPER MAKING

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)			
COURSE TITLE: INDUSTRY 4.0 APPLICATIONS IN PAPER MAKING		COURSE CODE: PPP 423	CONTACT HOURS: 4 HOURS/WEEK
		CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR II	SEMESTER II	PRE-REQUISITE: NIL	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with the knowledge and skill of Industry 4.0 technologies and their applications in pulp, paper, and paper products manufacturing.			
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the concept, pillars, and Industrial Internet of Things (IIoT) applications of Industry 4.0 in paper and paper products manufacturing. 2.0 Understand digital twins, simulation, artificial intelligence, machine learning, and big data analytics in paper manufacturing process. 3.0 Understand automation, robotics, augmented reality, and cybersecurity applications in smart paper mill operations. 4.0 Know the readiness, barriers, opportunities, and implementation pathways for Industry 4.0 adoption in paper industries.			

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)						
COURSE TITLE: INDUSTRY 4.0 APPLICATIONS IN PAPER MAKING			COURSE CODE: PPP 423		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR II	SEMESTER II		PRE-REQUISITE:		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with the knowledge and skills of Industry 4.0 technologies and their applications in pulp, paper, and paper products manufacturing.						
GENERAL OBJECTIVE 1.0: Understand the concept, pillars, and Industrial Internet of Things (IIoT) applications of Industry 4.0 in paper and paper products manufacturing.						
Week	THEORETICAL CONTENT			PRACTICAL CONTENT		
	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1-4	1.1 Outline the evolution, principles and enabling pillars of Industry 4.0 in paper manufacturing. 1.2 Explain Industrial Internet of Things architecture, sensors, edge devices, networks and cloud platforms. 1.3 Describe real-time	• Explain the evolution, principles and enabling pillars of Industry 4.0 in paper manufacturing. • Describe Industrial Internet of Things architecture, sensors, edge devices, networks and cloud platforms. • Discuss real-time data acquisition, communication protocols and process-monitoring systems in a paper mill.	White Board, Marker, charts, projector, textbooks, etc.	• Configure a basic sensor-to-dashboard IIoT monitoring setup for a selected paper-production variable. • Prepare an Industry 4.0 architecture diagram linking sensors, edge devices, controllers, networks and cloud services. • Collect real-time process data	Guide students to: • Configure a basic sensor-to-dashboard IIoT monitoring setup for a selected paper-production variable. • Prepare an Industry 4.0 architecture diagram linking sensors, edge devices, controllers, networks and cloud services. • Collect real-time	Computers, Simulation software, sensors or iiot trainer, process datasets, network-diagram tools, cybersecurity checklist.

	data acquisition, communication protocols and process-monitoring systems in a paper mill. 1.4 Explain conventional automation with cyber-physical and smart-manufacturing systems. 1.5 Describe Industry 4.0 applications in stock preparation, papermaking, converting, quality control and maintenance. 1.6 Explain the application a basic IIoT monitoring concept to a selected paper-production operation.	• Discuss conventional automation with cyber-physical and smart-manufacturing systems. • Describe Industry 4.0 applications in stock preparation, papermaking, converting, quality control and maintenance. • Discuss the application a basic IIoT monitoring concept to a selected paper-production operation.		• Identify abnormal trends or operating conditions. • Compare a conventional paper-mill operation with a cyber-physical or smart-manufacturing alternative. • Assess the expected productivity, quality, safety and sustainability benefits of the proposed connected system.	process data • Identify abnormal trends or operating conditions. • Compare a conventional paper-mill operation with a cyber-physical or smart-manufacturing alternative. • Assess the expected productivity, quality, safety and sustainability benefits of the proposed connected system.	
GENERAL OBJECTIVE 2.0: Understand digital twins, simulation, artificial intelligence, machine learning, and big data analytics in paper manufacturing process optimisation and quality management.						
5-7	2.1 Describe digital twins and distinguish	• Explain digital twins and distinguish product,	White Board,	• Create a simple digital model or simulation	Guide students to: • Create a simple	computers, simulation

	product, process and plant twin applications in paper manufacturing. 2.2 Explain the construction, calibration and use of digital twins for optimisation and troubleshooting. 2.3 Describe process simulation, advanced process control and model predictive control in papermaking operations. 2.4 Explain artificial-intelligence and machine-learning approaches for quality prediction and process optimisation. 2.5 Describe predictive-maintenance applications using vibration, temperature, current and equipment-condition data.	process and plant twin applications in paper manufacturing. • Describe the construction, calibration and use of digital twins for optimisation and troubleshooting. • Discuss process simulation, advanced process control and model predictive control in papermaking operations. • Discuss artificial-intelligence and machine-learning approaches for quality prediction and process optimisation. • Describe predictive-maintenance applications using vibration, temperature, current and equipment-condition data.	Marker, charts, projector, textbooks, etc.	of a selected paper-production process. • Run a process-simulation or model-predictive-control exercise • Evaluate the effect of changing selected operating variables. • Use an assigned paper-process dataset • Develop a basic quality-prediction or optimisation model. • Analyse vibration, temperature or current data • Identify indicators of impending equipment failure. • Apply statistical or computer-vision tools • Detect trends, anomalies or paper defects • Present the findings.	digital model or simulation of a selected paper-production process. • Run a process-simulation or model-predictive-control exercise • Evaluate the effect of changing selected operating variables. • Use an assigned paper-process dataset • Develop a basic quality-prediction or optimisation model. • Analyse vibration, temperature or current data • Identify indicators of impending equipment failure. • Apply statistical or computer-vision tools • Detect trends, anomalies or paper defects • Present the findings.	software, sensors or IIoT trainer, process datasets, network-diagram tools, cybersecurity checklist.
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GENERAL OBJECTIVE 3.0: Understand automation, robotics, augmented reality, and cybersecurity applications in smart paper mill operations.

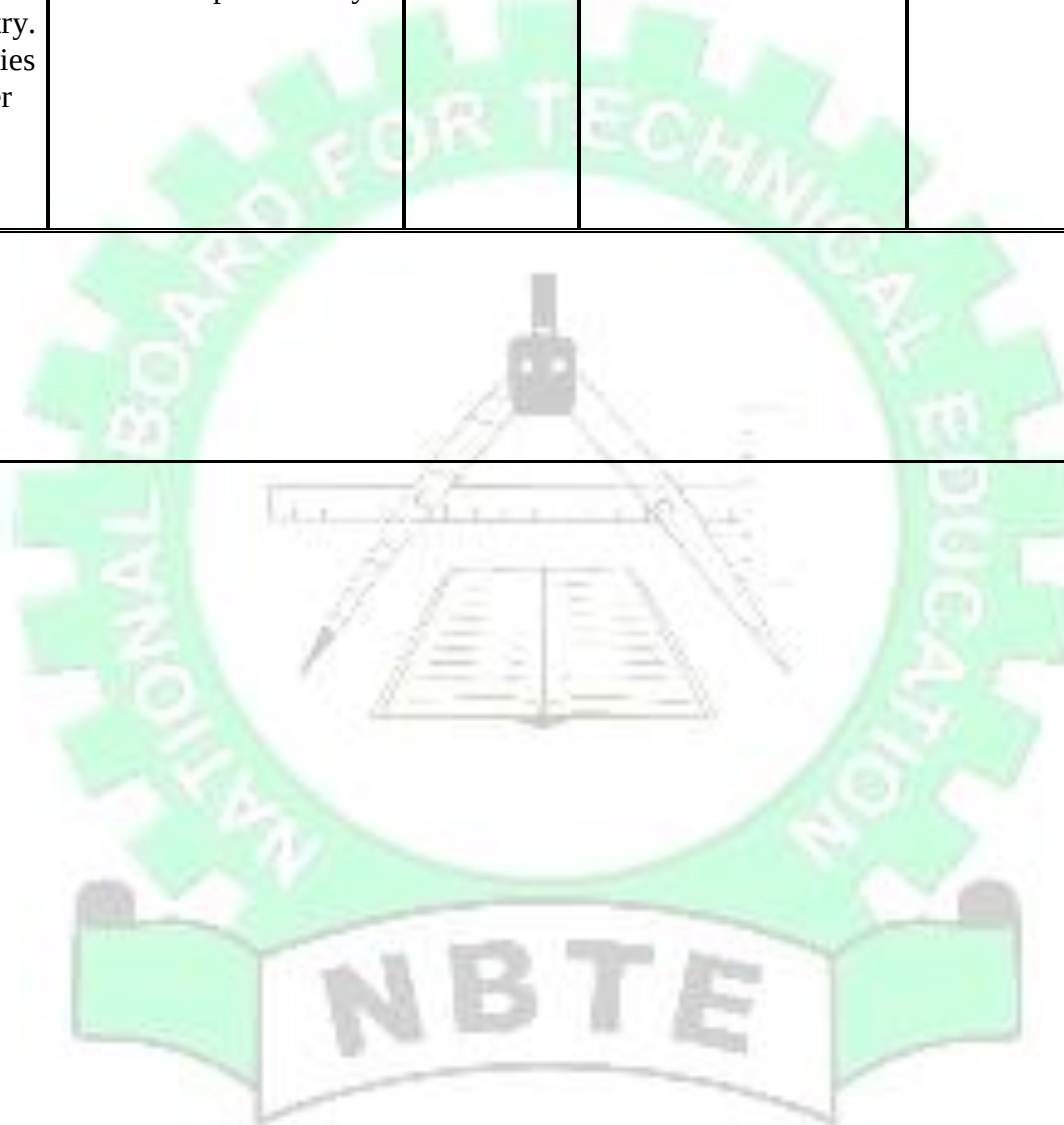
8-11	3.1 Describe automation, robotics and collaborative-robot systems used in paper production, finishing and inspection. 3.2 Explain augmented-reality applications for maintenance, training and digital work instructions. 3.3 Outline additive-manufacturing applications for paper-mill maintenance and spare-parts production. 3.4 Explain the architecture required to integrate sensors, controllers, operational technology, information technology and cloud platforms. 3.5 Explain industrial cyber security risks,	• Describe automation, robotics and collaborative-robot systems used in paper production, finishing and inspection. • Discuss augmented-reality applications for maintenance, training and digital work instructions. • Outline additive-manufacturing applications for paper-mill maintenance and spare-parts production. • Discuss the architecture required to integrate sensors, controllers, operational technology, information technology and cloud platforms. • Describe industrial cyber security risks, network segmentation, access control and data-governance requirements.	White Board, Marker, charts, projector, textbooks, etc.	• Identify suitable automation, robotics, augmented-reality and additive-manufacturing applications for selected paper-mill operations. • Prepare a basic smart-mill network diagram showing sensors, controllers, OT, IT and cloud connections. • Conduct a cyber-security risk assessment and recommend controls for an assigned smart-mill scenario. • Demonstrate an AR-assisted maintenance, cobot or digital work-instruction concept using available simulation tools.	Guide students to: • Identify suitable automation, robotics, augmented-reality and additive-manufacturing applications for selected paper-mill operations. • Prepare a basic smart-mill network diagram showing sensors, controllers, OT, IT and cloud connections. • Conduct a cyber-security risk assessment and recommend controls for an assigned smart-mill scenario. • Demonstrate an AR-assisted maintenance, cobot or digital work-instruction concept using available	computers, simulation software, sensors or IIoT trainer, process datasets, network-diagram tools, cybersecurity checklist.
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	network segmentation, access control and data-governance requirements.				simulation tools.	
GENERAL OBJECTIVE 4.0: Know the readiness, barriers, opportunities, and implementation pathways for Industry 4.0 adoption in paper industries.						
12-15	4.1 Outline the current state of technology adoption in paper and packaging industries and the key gaps relative of. 4.2 Explain to global Industry and standards. 4.3 Describe the main barriers to Industry and adoption in Nigerian paper manufacturing. 4.4 Explain the opportunities presented by Industry. 4.5 Describe for Nigerian paper manufacturers and a phased implementation	• Discuss the current state of technology adoption in paper and packaging industries and the key gaps relative of. • Describe to global Industry and standards. • Explain the main barriers to Industry and adoption in Nigerian paper manufacturing. • Discuss the opportunities presented by Industry. • Describe for Nigerian paper manufacturers and a phased implementation roadmap for introducing Industry. • Discuss technologies in a Nigerian paper mill	White Board, Marker, charts, projector, textbooks, etc.	• Identify current capabilities, priority technology gaps, barriers and opportunities. • Develop a phased implementation roadmap with recommended technologies, responsibilities and estimated resources. • Present a justified smart-manufacturing improvement proposal.	Guide students to: • Identify current capabilities, priority technology gaps, barriers and opportunities. • Develop a phased implementation roadmap with recommended technologies, responsibilities and estimated resources. • Present a justified smart-manufacturing improvement proposal.	computers, simulation software, sensors or IIoT trainer, process datasets, network-diagram tools, cybersecurity checklist.

	roadmap for introducing Industry. 4.6 Explain technologies in a Nigerian paper mill and a simple Industry.	and a simple Industry.				
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COURSE ASSESSMENT:

Course Work:	10%
Test/Assignments:	10%
Practical:	40%
Examination:	40%
Total:	100%



PULP, PAPER AND DOWNSTREAM INDUSTRY

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)

COURSE TITLE: PULP, PAPER AND DOWNSTREAM INDUSTRY	COURSE CODE: PPP 424	CONTACT HOURS: 3 HOURS/WEEK
	CREDIT UNIT: 3	THEORETICAL:1 HOUR/WEEK
YEAR II	SEMESTER II	PRE-REQUISITE: NIL
		PRACTICAL: 2 HOURS/WEEK

GOAL. This course is designed to equip students with the knowledge and skills needed for pulp, paper, and downstream product manufacturing operations.

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

- 1.0 Understand the historical development of the pulp and paper industry in Nigeria;
- 2.0 Understand the structure and operations of the Nigerian pulp, paper and downstream sectors;
- 3.0 Know the causes and implications of the decline of integrated pulp and paper mills in Nigeria;
- 4.0 Understand the role of downstream paper industries in national industrial development;
- 5.0 Know emerging opportunities and investment prospects;
- 6.0 Understand value chain concepts in analysing the Nigerian paper industry.

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)

COURSE TITLE: PULP, PAPER AND DOWNSTREAM INDUSTRY	COURSE CODE: PPP 424	CONTACT HOURS: 3 HOURS/WEEK
	CREDIT UNIT: 3	THEORETICAL: 1 HOUR/WEEK
YEAR II	SEMESTER II	PRE-REQUISITE: NIL
		PRACTICAL: 2 HOURS/WEEK

COURSE SPECIFICATION: THEORETICAL AND PRACTICAL

GOAL: This course is designed to equip students with the knowledge and skills needed for pulp, paper, and downstream product manufacturing operations.

GENERAL OBJECTIVE 1.0: Understand the historical development of the pulp and paper industry in Nigeria

Week	THEORETICAL CONTENT			PRACTICAL CONTENT		
	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Explain the evolution of the Nigerian pulp and paper industry. 1.2 Describe the establishment of Nigerian Paper Mill (NPM), Nigerian Newsprint Manufacturing Company (NNMC) and Iwopin Pulp and Paper Company (IPPC). 1.3 Explain the contribution of the mills in. 1.4 Explain to industrial	- Discuss the evolution of the Nigerian pulp and paper industry using relevant examples, diagrams and illustrations. - Explain the establishment of Nigerian Paper Mill (NPM), Nigerian Newsprint Manufacturing Company (NNMC) and Iwopin Pulp and Paper Company (IPPC) with relevant examples, diagrams or case materials. - Describe the contribution of the mills in using relevant examples, diagrams and illustrations.	White Board, Marker, charts, projector, textbooks, etc.	- Construct a chronological timeline of major developments in the Nigerian pulp and paper industry., Locate NPM, NNMC and IPPC on a map - Compile their original capacities, products and industrial roles from supplied records. - Prepare a comparative case summary of the three integrated mills and their contributions to national development.	Guide students to: - Construct a chronological timeline of major developments in the Nigerian pulp and paper industry., Locate NPM, NNMC and IPPC on a map - Compile their original capacities, products and industrial roles from supplied	Industry maps, Company records, Value-chain templates, field-visit checklist, camera, computer.

	development.	• Discuss to industrial development using relevant examples, diagrams and illustrations.		• Demonstrate the contribution of the mills in through an assigned practical exercise. • Demonstrate industrial development through an assigned practical exercise.	- records. • Prepare a comparative case summary of the three integrated mills and their contributions to national development. • Demonstrate the contribution of the mills in through an assigned practical exercise. • Demonstrate industrial development through an assigned practical exercise.	
GENERAL OBJECTIVE 2.0: Understand the structure and operations of the Nigerian pulp, paper and downstream sectors.						
4-7	2.1 Explain the paper industry value chain. 2.2 Describe upstream and downstream sectors. 2.3 Outline the major downstream industries. 2.4 Explain the	• Discuss the paper industry value chain. • Explain upstream and downstream sectors. • Explain the major downstream industries. • Discuss the production processes and products of the Nigerian pulp and	White Board, Marker, charts, projector, textbooks, etc.	• Map the upstream, midstream and downstream segments of the Nigerian paper-industry value chain. • Classify representative enterprises, production processes and products within each segment.	Guide students to: • Map the upstream, midstream and downstream segments of the Nigerian paper-industry value	Industry maps, company records, value-chain templates, field-visit checklist, camera, computer.

	production processes and products of the Nigerian pulp and paper sector. 2.5 Outline the challenges and opportunities in the Nigerian pulp, paper and downstream industries. 2.6 Describe the linkages between pulp production, paper manufacturing and downstream paper conversion industries.	paper sector. • Explain the challenges and opportunities in the Nigerian pulp, paper and downstream industries with relevant examples, diagrams or case materials. • Explain the linkages between pulp production, paper manufacturing and downstream paper conversion industries.		• Conduct a field visit or virtual plant study • Document material, product and information flows. • Identify operational linkages, constraints and opportunities across the sectors.	chain. • Classify representative enterprises, production processes and products within each segment. • Conduct a field visit or virtual plant study • Document material, product and information flows. • Identify operational linkages, constraints and opportunities across the sectors.	
GENERAL OBJECTIVE 3.0: Know the causes and implications of the declining integrated pulp and paper mills in Nigeria.						
8-11	3.1 Outline factors responsible for mill collapse. 3.2 Explain economic consequences of mill closure. 3.3 Explain the impact of the decline of	• Explain factors responsible for mill collapse. • Discuss economic consequences of mill closure using relevant examples, diagrams and illustrations. • Discuss the impact of the	White Board, Marker, charts, projector, textbooks, etc.	• Analyse supplied operational and economic information on a closed or underperforming Nigerian paper mill. • Classify the technical, managerial, financial,	Guide students to: • Analyse supplied operational and economic information on a closed or underperforming	Industry maps, company records, value-chain templates, field-visit checklist, camera, computer.

	integrated pulp and paper mills on Nigeria's paper industry and economy. 3.4 3.4 Explain the implications of increased dependence on imported paper products. 3.5 Describe strategies for the revitalisation and sustainable development of the Nigerian pulp and paper industry.	decline of integrated pulp and paper mills on Nigeria's paper industry and economy, diagrams and illustrations. • Discuss the implications of increased dependence on imported paper products. • Explain strategies for the revitalisation and sustainable development of the Nigerian pulp and paper industry.		policy and market factors responsible for decline. • Estimate selected consequences of mill closure, including lost output, employment or import dependence. • Develop a prioritised revitalisation and sustainability action plan.	Nigerian paper mill. • Classify the technical, managerial, financial, policy and market factors responsible for decline. • Estimate selected consequences of mill closure, including lost output, employment or import dependence. • Develop a prioritised revitalisation and sustainability action plan.	
GENERAL OBJECTIVE 4.0: Understand the role of downstream paper industries in national industrial development.						
12-13	4.1 Outline the concept and scope of downstream paper industries. 4.2 Explain the importance of downstream	• Explain the concept and scope of downstream paper industries. • Discuss the importance of downstream industries. • Describe the major downstream paper products	White Board, Marker, charts, projector, textbooks, etc.	• Identify common downstream paper products and their applications. • Assemble a simple downstream paper product such as an	Guide students to: • Identify common downstream paper products and their	Industry maps, company records, value-chain templates, field-visit checklist, camera,

	industries. 4.3 Describe the major downstream paper products and their applications. 4.4 Explain the contribution of downstream paper industries to economic development 4.5 Describe the role of downstream paper industries in supporting manufacturing, packaging, printing, and publishing sectors. 4.6 Explain the impact of downstream paper industries on value addition and industrial diversification.	and their applications. • Discuss the contribution of downstream paper industries to economic development • Discuss the role of downstream paper industries in supporting manufacturing, packaging, printing, and publishing sectors. • Discuss the impact of downstream paper industries on value addition and industrial diversification.		envelope, notebook, carton or paper bag. • Document the materials, operations, costs and value added during conversion. • Evaluate how the selected downstream operation supports manufacturing, packaging, printing or publishing.	applications. • Assemble a simple downstream paper product such as an envelope, notebook, carton or paper bag. • Document the materials, operations, costs and value added during conversion. • Evaluate how the selected downstream operation supports manufacturing, packaging, printing or publishing.	computer.
GENERAL OBJECTIVE 5.0: Know emerging opportunities and investment prospects						
14	5.1 Explain emerging opportunities in the pulp, paper, and downstream paper industry. 5.2 Describe investment	• Discuss emerging opportunities in the pulp, paper, and downstream paper industry. • Describe investment prospects within the pulp	White Board, Marker, charts, projector, textbooks,	• Identify an emerging investment or entrepreneurship opportunity in the Nigerian pulp, paper or downstream sector.	Guide students to: • Identify an emerging investment or entrepreneurship	Industry maps, company records, value-chain templates, field-visit checklist,

	prospects within the pulp and paper value chain. 5.3 Explain the potential of local raw materials for paper industry development. 5.4 Describe entrepreneurship opportunities in paper conversion and downstream products. 5.5 Explain factors influencing investment decisions in the pulp and paper industry. 5.6 Describe business and investment opportunities in the Nigerian paper sector.	and paper value chain. • Explain the potential of local raw materials for paper industry development. • Discuss entrepreneurship opportunities in paper conversion and downstream products. • Discuss factors influencing investment decisions in the pulp and paper industry. • Describe business and investment opportunities in the Nigerian paper sector.	etc.	• Assess local raw-material availability, market demand, technology needs, risks and regulatory requirements. • Prepare a preliminary investment profile with estimated capacity, capital needs and expected outputs. • Present the selected opportunity to a review panel. • Demonstrate the potential of local raw materials for paper industry development through an assigned practical exercise.	opportunity in the Nigerian pulp, paper or downstream sector. • Assess local raw-material availability, market demand, technology needs, risks and regulatory requirements. • Prepare a preliminary investment profile with estimated capacity, capital needs and expected outputs. • Present the selected opportunity to a review panel. • Demonstrate the potential of local raw materials for paper industry development through an assigned practical	camera, computer.
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					exercise.	
GENERAL OBJECTIVE 6.0: Understand value chain concepts in analysing the Nigerian paper industry.						
15	6.1 Explain the concept and components of the paper industry value chain. 6.2 Describe the key actors and activities within the Nigerian paper industry value chain. 6.3 Describe the flow of raw materials, products, information, and services across the paper value chain. 6.4 Explain the challenges and opportunities affecting the Nigerian paper industry value chain. 6.5 Explain the contributions of upstream, midstream, and downstream sectors to the development of the Nigerian paper industry.	• Explain the concept and components of the paper industry value chain. • Discuss the key actors and activities within the Nigerian paper industry value chain. • Describe the flow of raw materials, products, information, and services across the paper value chain. • Discuss the challenges and opportunities affecting the Nigerian paper industry value chain. • Describe the contributions of upstream, midstream, and downstream sectors to the development of the Nigerian paper industry. • Describe strategies for improving efficiency and competitiveness within the Nigerian paper industry value chain.	White Board, Marker, charts, projector, textbooks, etc.	• Develop an integrated value-chain map showing actors, materials, products, information, services and financial flows. • Identify bottlenecks, waste points, weak linkages and competitiveness gaps within the Nigerian paper value chain • Prioritise practical interventions for improving efficiency, local sourcing, collaboration and market access. • Prepare a value-chain improvement report with measurable recommendations. • Demonstrate the contributions of upstream, midstream, and downstream sectors to the development of the Nigerian paper	Guide students to: • Develop an integrated value-chain map showing actors, materials, products, information, services and financial flows. • Identify bottlenecks, waste points, weak linkages and competitiveness gaps within the Nigerian paper value chain • Prioritise practical interventions for improving efficiency, local sourcing, collaboration and market access.	Industry maps, company records, value-chain templates, field-visit checklist, camera, computer.

	6.6 Describe strategies for improving efficiency and competitiveness within the Nigerian paper industry value chain.			industry through an assigned practical exercise.	• Prepare a value-chain improvement report with measurable recommendations. • Demonstrate the contributions of upstream, midstream, and downstream sectors to the development of the Nigerian paper industry through an assigned practical exercise.	
COURSE ASSESSMENT: Course Work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

PACKAGING, PRINTING AND CONVERTING TECHNOLOGY

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)

COURSE TITLE: PACKAGING, PRINTING AND CONVERTING TECHNOLOGY	COURSE CODE: PPP 425	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR II	SEMESTER II	PRE-REQUISITE:
		PRACTICAL: 3 HOURS/WEEK

GOAL. This course is designed to equip students with the knowledge and skills required for packaging design, printing processes, and converting operations in the paper and packaging industry

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

- 1.0 Understand the principles and processes of paper packaging;
- 2.0 Know techniques used in corrugated board and carton manufacturing;
- 3.0 Know operations and technologies used in printing and publishing;
- 4.0 Understand principles and applications of security printing.

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)

COURSE TITLE: PACKAGING, PRINTING AND CONVERTING TECHNOLOGY	COURSE CODE: PPP 425	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 3	THEORETICAL: 1 HOUR/WEEK
YEAR II	SEMESTER II	PRE-REQUISITE:
		PRACTICAL: 3 HOURS/WEEK

COURSE SPECIFICATION: THEORETICAL AND PRACTICAL

GOAL: This course is designed to equip students with the knowledge and skills required for packaging design, printing processes, and converting operations in the paper and packaging industry

GENERAL OBJECTIVE 1.0: Understand the principles and processes of paper packaging

Week	THEORETICAL CONTENT			PRACTICAL CONTENT		
	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Explain the concept and functions of paper packaging. 1.2 Describe paper packaging materials and products. 1.3 Explain properties required for paper packaging materials. 1.4 Describe the paper packaging production chain. 1.5 Explain paperboard and carton manufacturing processes. 1.6 Explain	• Discuss the concept and functions of paper packaging. • Describe paper packaging materials and products. • Explain properties required for paper packaging materials. • Describe the paper packaging production chain. • Discuss paperboard and carton manufacturing processes.	White Board, Marker, charts, projector, textbooks, etc.	• Carry out Paper and board packaging. • Identify packaging products. • Compare material properties. • Draw production flow charts. • Design package layouts. • Produce simple paper bags. • Conduct quality tests such as:	Guide students to: • Carry out Paper and board packaging. • Identify packaging products. • Compare material properties. • Draw production flow charts. • Design package layouts. • Produce simple paper bags. • Conduct quality tests such as: Grammage, burst strength,	Paperboard and corrugated samples, cutting and creasing tools, CAD software, rulers, adhesives, compression-test equipment, PPE.

	environmental considerations in paper packaging production.	• Discuss environmental considerations in paper packaging production.		Grammage, burst strength, compression strength, Cobb test.	compression strength, Cobb test.	
GENERAL OBJECTIVE 2.0: Know techniques used in corrugated board and carton manufacturing.						
4-7	2.1 Explain the structure and components of corrugated board. 2.2 Describe types of corrugated boards and cartons. 2.3 Explain raw materials used in corrugated board production. 2.4 Describe the corrugating process. 2.5 Explain adhesive preparation and application in corrugated board production. 2.6 Explain carton design principles.	• Discuss the structure and components of corrugated board. • Describe types of corrugated boards and cartons. • Discuss raw materials used in corrugated board production. • Describe the corrugating process. • Explain adhesive preparation and application in corrugated board production. • Discuss carton design principles.	White Board, Marker, charts, projector, textbooks, etc.	• Select appropriate raw materials for corrugated board production. • Apply starch adhesives. • Design and fabricate corrugated cartons. • Apply printing and finishing to paperboard. • Test physical properties of paperboard materials.	Guide students to: • Select appropriate raw materials for corrugated board production. • Apply starch adhesives. • Design and fabricate corrugated cartons. • Apply printing and finishing to paperboard. • Test physical properties of paperboard materials.	Paperboard and corrugated samples, cutting and creasing tools, CAD software, rulers, adhesives, compression-test equipment, PPE.
GENERAL OBJECTIVE 3.0: Know operations and technologies used in printing and publishing.						
8-11	3.1 Outline the role of printing and publishing in the paper value chain. 3.2 Explain printing	• Explain the role of printing and publishing in the paper value chain. • Discuss printing	White Board, Marker, charts, projector, textbooks, etc.	• Identify printed paper products used in daily life. • Draw an offset	Guide students to: • Identify printed paper products used in daily life. • Draw an offset	Paperboard and corrugated samples, cutting and creasing tools, CAD

	processes used in industry and offset lithographic printing technology. 3.3 Describe flexographic printing technology. 3.4 Explain gravure and screen printing technologies. 3.5 Describe digital printing technologies. 3.6 Explain printing inks and substrates used in printing operations and pre- and post-press operations. 3.7 Describe publishing processes and workflows.	processes used in industry and offset lithographic printing technology. - Describe flexographic printing technology. - Discuss gravure and screen printing technologies. - Describe digital printing technologies. - Discuss printing inks and substrates used in printing operations and pre- and post-press operations. - Explain publishing processes and workflows.		printing system. - Compare print quality from different method. - Produce digital print samples. - Create simple page layouts. - Write a technical report on a visit to a printing industry.	printing system. - Compare print quality from different method. - Produce digital print samples. - Create simple page layouts. - Write a technical report on a visit to a printing industry.	software, rulers, adhesives, compression-test equipment, PPE.
GENERAL OBJECTIVE 4.0: Understand principles and applications of security printing						
12-15	4.1 Explain the concept and importance of security printing. 4.2 Describe products that require security printing. 4.3 Describe the principles of security printing.	- Discuss the concept and importance of security printing - Explain products that require security printing - Explain the principles of security printing - Discuss physical	White Board, Marker, charts, projector, textbooks, etc.	- Examine different security printed documents. - Compare genuine and counterfeit samples. - Analyze	Guide students to: - Examine different security printed documents. - Compare genuine and counterfeit samples. - Analyze properties of security paper. - Demonstrate the	Paperboard and corrugated samples, cutting and creasing tools, CAD software, rulers, adhesives, compression-test equipment, PPE.

	4.4 Explain physical security features used in paper products. 4.5 Explain printing-based security features. 4.6 Explain modern digital security technologies. 4.7 Explain security paper manufacture and specifications.	security features used in paper products • Discuss printing-based security features • Discuss modern digital security technologies • Discuss security paper manufacture and specifications		properties of security paper. • Demonstrate the concept and importance of security printing through an assigned practical exercise.	concept and importance of security printing through an assigned practical exercise.	
COURSE ASSESSMENT: Course Work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

TISSUE AND SPECIALTY PAPER PRODUCT CONVERSION TECHNOLOGY

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)			
COURSE TITLE: TISSUE AND SPECIALTY PAPER PRODUCT CONVERSION TECHNOLOGY		COURSE CODE: PPP 426	CONTACT HOURS: 4 HOURS/WEEK
		CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR II	SEMESTER II	PRE-REQUISITE: NIL	PRACTICAL: 3 HOURS/WEEK
GOAL. This course is designed to equip students with knowledge and skills required for the manufacture, conversion, and quality management of tissue and specialty paper products.			
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand manufacture and conversion of tissue and sanitary products; 2.0 Know tissue-converting processes; 3.0 Understand the properties and applications of specialty and technical papers.			

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)

COURSE TITLE: TISSUE AND SPECIALTY PAPER PRODUCT CONVERSION TECHNOLOGY	COURSE CODE: PPP 426	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR II	SEMESTER II	PRE-REQUISITE: NIL
		PRACTICAL: 3 HOURS/WEEK

COURSE SPECIFICATION: THEORETICAL AND PRACTICAL

GOAL: This course is designed to provide students with knowledge and skills required for the manufacture, conversion, and quality management of tissue and specialty paper products.

GENERAL OBJECTIVE 1.0: Understand manufacture and conversion of tissue and sanitary products.

Week	THEORETICAL CONTENT			PRACTICAL CONTENT		
	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Outline the classification of tissue and sanitary products. 1.2 Explain the raw materials used sanitary product manufacture and the tissue manufacturing process. 1.3 Describe the manufacture of toilet rolls and facial tissues. 1.4 Explain the manufacture of paper napkins and paper	• Explain the classification of tissue and sanitary products. • Discuss the raw materials used sanitary product manufacture and the tissue manufacturing process. • Explain the manufacture of toilet rolls and facial tissues. • Discuss the manufacture of paper napkins and paper towels. • Explain the manufacture of sanitary pads and diapers. • Discuss absorbency and softness requirements in tissue products and hygiene and safety requirements in	White Board, Marker, charts, projector, textbooks, etc.	• Identify products for tissue manufacturing. • Examine raw material samples for tissue manufacturing. • Identify various tissue and sanitary products. • Compare conventional and eco-friendly tissue products. • Select appropriate raw materials for tissue production. • Convert jumbo tissue rolls into finished products.	Guide students to: • Identify products for tissue manufacturing. • Examine raw material samples for tissue manufacturing. • Identify various tissue and sanitary products. • Compare conventional and eco-friendly tissue products. • Select	Tissue base paper, converting-machine model or equipment, embossing and cutting tools, product-testing instruments, PPE.

	towels. 1.5 Describe the manufacture of sanitary pads and diapers. 1.6 Explain absorbency and softness requirements in tissue products and hygiene and safety requirements in tissue and sanitary product manufacture. 1.7 Describe the similarities, differences and selection criteria relating to conventional and eco-friendly tissue products.	tissue and sanitary product manufacture. • Discuss the similarities, differences and selection criteria relating to conventional and eco-friendly tissue products.			appropriate raw materials for tissue production. • Convert jumbo tissue rolls into finished products.	
GENERAL OBJECTIVE 2.0: Know tissue converting processes						
4-7	2.1 Outline the concept and importance of tissue converting. 2.2 Explain the raw materials used in tissue conversion. 2.3 Describe tissue rewinding operations. 2.4 Explain perforation	• Outline the concept and importance of tissue converting. • Discuss the raw materials used in tissue conversion. • Describe tissue rewinding operations. • Explain perforation and cutting operations and	White Board, Marker, charts, projector, textbooks, etc.	• Identify different tissue products. • Compare different tissue grades. • Produce simple embossed patterns. • Perform perforation exercise • Fold tissue products	Guide students to: • Identify different tissue products. • Compare different tissue grades. • Produce simple embossed	Tissue base paper, converting-machine model or equipment, embossing and cutting tools, product-testing instruments,

	and cutting operations and folding processes in tissue production. 2.5 Describe packaging operations in tissue conversion. 2.6 Explain quality control requirements in tissue conversion. 2.7 Describe common defects in tissue converting.	folding processes in tissue production. • Discuss packaging operations in tissue conversion. • Explain quality control requirements in tissue conversion. • Discuss common defects in tissue converting.		into different formats • Package tissue products. • Identify defects in tissue product.	patterns. • Perform perforation exercise • Fold tissue products into different formats • Package tissue products. • Identify defects in tissue product.	PPE.
GENERAL OBJECTIVE 3.0: Understand the properties and applications of specialty papers.						
8-11	3.1 Outline the concept and classification of specialty papers. 3.2 Explain conventional papers and specialty papers. 3.3 Describe the physical properties of specialty papers. 3.4 Explain thermal papers and their applications and the properties and applications of filtration papers. 3.5 Describe medical and sanitary paper products.	• Explain the concept and classification of specialty papers. • Discuss conventional papers and specialty papers. • Describe the physical properties of specialty papers. • Discuss thermal papers and their applications and the properties and applications of filtration papers. • Describe medical and sanitary paper products. • Discuss electrical and insulation papers. • Describe security papers	White Board, Marker, charts, projector, textbooks, etc.	• Carry out comparative analysis of paper properties using magnifying glass and microscope. • Determine physical properties of selected papers. • Determine pH and chemical resistance of papers. • Identify thermal papers. • Conduct filtration experiment. • Examine greaseproof and waxed papers. • Test grease and	Guide students to: • Carry out comparative analysis of paper properties using magnifying glass and microscope. • Determine physical properties of selected papers. • Determine pH and chemical resistance of papers. • Identify thermal papers.	tissue base paper, converting-machine model or equipment, embossing and cutting tools, product-testing instruments, PPE.

	3.6 Explain electrical and insulation papers. 3.7 Describe security papers and anti-counterfeiting technologies.	and anti-counterfeiting technologies.		moisture resistance.	• Conduct filtration experiment. • Examine greaseproof and waxed papers. • Test grease and moisture resistance.	
COURSE ASSESSMENT: Course Work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

RECYCLED FIBRE, MATERIALS AND DOWNSTREAM PLANT OPERATIONS

PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)

COURSE TITLE: RECYCLED FIBRE, MATERIALS AND DOWNSTREAM PLANT OPERATIONS		COURSE CODE: PPP 427	CONTACT HOURS: 4 HOURS/WEEK
		CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR II	SEMESTER I	PRE-REQUISITE:	PRACTICAL: 3 HOURS/WEEK

GOAL: This course is designed to equip students with Knowledge and skills in recycled fibre processing and downstream plant operations in the paper industry

GENERAL OBJECTIVES

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

- 1.0 Understand the principles of recycled fibre utilization in paper and packaging industries;
- 2.0 Know waste paper recovery and recycling techniques in paper production systems;
- 3.0 Understand the functions and applications of adhesives, inks, coatings, and auxiliary materials used in downstream paper industries;
- 4.0 Understand preventive maintenance practices in downstream paper manufacturing facilities.

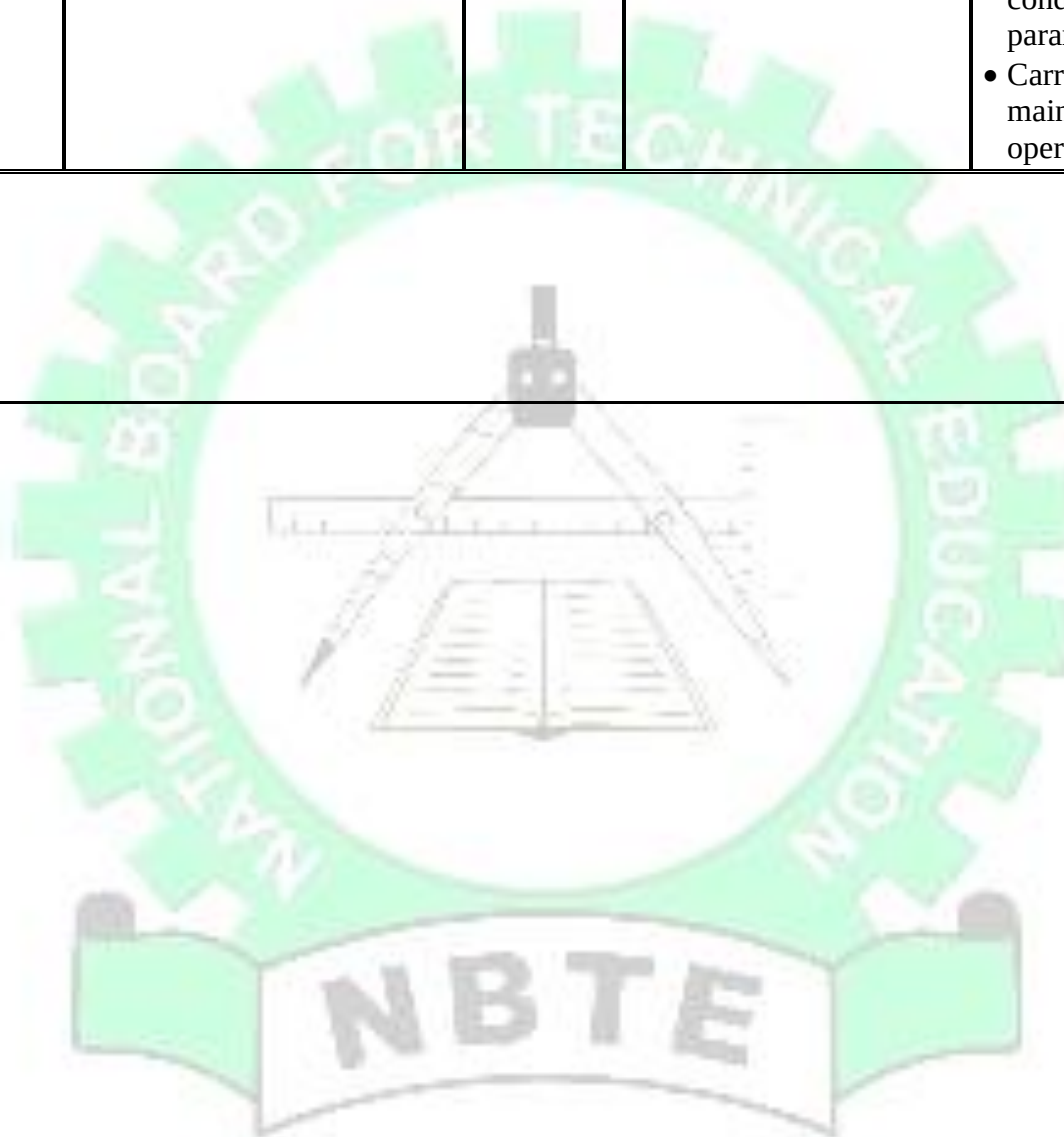
PROGRAMME: HIGHER NATIONAL DIPLOMA WOOD AND PAPER TECHNOLOGY (PAPER AND PAPER PRODUCTS TECHNOLOGY OPTION)						
COURSE TITLE: RECYCLED FIBRE, MATERIALS AND DOWNSTREAM PLANT OPERATIONS				COURSE CODE: PPP 427		CONTACT HOURS: 4 HOURS/WEEK
				CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK
YEAR II		SEMESTER I		PRE-REQUISITE:		PRACTICAL: 3 HOURS/WEEK
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with Knowledge and skills in recycled fibre processing and downstream plant operations in the paper industry						
GENERAL OBJECTIVE 1.0: Understand the principles of recycled fibre utilization in paper and packaging industries.						
Week	THEORETICAL CONTENT			PRACTICAL CONTENT		
	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1-3	1.1 Outline the concept and importance of recycled fibre utilization in paper and packaging industries. 1.2 Explain sources of recycled fibres used in paper manufacturing. 1.3 Describe the collection and recovery systems for waste paper. 1.4 Explain the processing stages of recycled fibre	• Explain the concept and importance of recycled fibre utilization in paper and packaging industries. • Discuss sources of recycled fibres used in paper manufacturing. • Describe the collection and recovery systems for waste paper. • Discuss the processing stages of recycled fibre preparation and deinking technologies used in paper recycling. • Explain the effects of recycling on fibre	White Board, Marker, charts, projector, textbooks, etc.	• Identify recycled paper products available locally • Sort waste paper according to grades. • Visit a waste paper collection centre and document operations. • Test fibre quality parameters of recycled pulp. • Compare physical properties of virgin and recycled pulp hand sheets.	Guide students to: • Identify recycled paper products available locally • Sort waste paper according to grades. • Visit a waste paper collection centre and document operations. • Test fibre quality parameters of recycled pulp. • Compare physical	Waste-paper samples, sorting bins, pulper, screens, flotation or washing setup, adhesives and inks, maintenance tools, PPE.

	preparation and deinking technologies used in paper recycling. 1.5 Describe the effects of recycling on fibre properties. 1.6 Explain environmental benefits of recycled fibre utilization. 1.7 Explain the challenges associated with recycled fibre utilization.	properties. • Discuss environmental benefits of recycled fibre utilization. • Explain the challenges associated with recycled fibre utilization.			properties of virgin and recycled pulp hand sheets.	
GENERAL OBJECTIVE 2.0: Know waste paper recovery and recycling techniques in paper production systems.						
4-7	2.1 Explain the importance of waste paper recovery in sustainable paper production. 2.2 Explain sources and categories of waste paper suitable for recycling. 2.3 Explain the application procedure for waste paper collection, sorting, and storage procedures.	• Explain the importance of waste paper recovery in sustainable paper production. • Discuss sources and categories of waste paper suitable for recycling. • Explain the application procedure for waste paper collection, sorting, and storage procedures. • Describe the process of waste paper recycling. • Explain how to perform waste paper pulping	White Board, Marker, charts, projector, textbooks, etc.	• Classify waste paper generated within the institution. • Produce recycled paper sheets from recovered fibres. • Sort waste paper into different grades according to industry standards. • Organize a waste paper collection and sorting exercise. • Conduct flotation de-inking of printed waste	Guide students to: • Classify waste paper generated within the institution. • Produce recycled paper sheets from recovered fibres. • Sort waste paper into different grades according to industry standards. • Organize a waste	Waste-paper samples, sorting bins, pulper, screens, flotation or washing setup, adhesives and inks, maintenance tools, PPE.

	2.4 Explain the process of waste paper recycling. 2.5 Describe how to perform waste paper pulping operations. 2.6 Explain de-inking processes in paper recycling.	operations. • Explain de-inking processes in paper recycling.		paper. • Test recycled pulp properties • Compare with virgin pulp.	paper collection and sorting exercise. • Conduct flotation de-inking of printed waste paper. • Test recycled pulp properties • Compare with virgin pulp.	
GENERAL OBJECTIVE 3.0: Understand the functions and applications of adhesives, inks, coatings, and auxiliary materials used in downstream paper industries. .						
8-11	3.1 Outline the functions of adhesives in paper and packaging industries. 3.2 Explain adhesives used in downstream paper industries. 3.3 Describe properties and selection criteria for adhesives. 3.4 Explain the composition and functions of printing inks and printing inks used in paper industries. 3.5 Describe the functions of paper	• Explain the functions of adhesives in paper and packaging industries. • Describe adhesives used in downstream paper industries. • Describe properties and selection criteria for adhesives. • Describe the composition and functions of printing inks and printing inks used in paper industries. • Explain the functions of paper coatings. • Explain the functions of auxiliary materials in paper conversion.	White Board, Marker, charts, projector, textbooks, etc.	• Compare adhesive performance on paper substrates. • Identify ink components. • Identify coating materials used in paper production. • Evaluate ink suitability for different paper products. • Compare coated and uncoated papers. • Prepare simple coating mixture. • Identify auxiliary materials.	Guide students to: • Compare adhesive performance on paper substrates. • Identify ink components. • Identify coating materials used in paper production. • Evaluate ink suitability for different paper products. • Compare coated and uncoated	Waste-paper samples, sorting bins, pulper, screens, flotation or washing setup, adhesives and inks, maintenance tools, PPE.

	coatings. 3.6 Describe the functions of auxiliary materials in paper conversion. 3.7 Explain the material selection for specific paper products through case studies.	Describe the material selection for specific paper products through case studies.			papers. - Prepare simple coating mixture. - Identify auxiliary materials.	
GENERAL OBJECTIVE 4.0: Understand preventive maintenance practices in downstream paper manufacturing facilities						
12-15	4.1 Explain the concept and importance of preventive maintenance in paper manufacturing facilities. 4.2 Describe common causes of equipment failure in paper manufacturing facilities. 4.3 Explain lubrication systems and maintenance requirements. 4.4 Describe preventive maintenance schedules for downstream equipment.	- Discuss the concept and importance of preventive maintenance in paper manufacturing facilities. - Explain common causes of equipment failure in paper manufacturing facilities. - Describe lubrication systems and maintenance requirements. - Discuss preventive maintenance schedules for downstream equipment.	White Board, Marker, charts, projector, textbooks, etc.	- Identify maintenance practices in selected paper plants. - Inspect mechanical components for wear and deterioration. - Perform routine maintenance on paper converting equipment. - Maintain hydraulic and pneumatic systems used in paper plants. - Monitor machine condition parameters - Carry out routine maintenance operations.	Guide students to: - Identify maintenance practices in selected paper plants. - Inspect mechanical components for wear and deterioration. - Perform routine maintenance on paper converting equipment. - Maintain hydraulic and pneumatic systems used in paper plants. - Monitor machine	Waste-paper samples, sorting bins, pulper, screens, flotation or washing setup, adhesives and inks, maintenance tools, PPE.

					condition parameters • Carry out routine maintenance operations.	
COURSE ASSESSMENT: Course Work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						



LIST OF MINIMUM RESOURCES/ PHYSICAL FACILITIES

SECTION A: WOOD ANATOMY AND WOOD SCIENCE LABORATORY

S/NO	ITEM	QUANTITY
1	Binocular compound microscope (with digital camera attachment)	15
2	Stereo/dissecting microscope	5
3	Microtome (rotary, with blade holder)	2
4	Microscope slides, cover slips, and staining reagents	60 sets
5	Digital image analysis software (e.g. ImageJ or equivalent)	5 licence
6	Hand lens/magnifying glass (10× minimum)	30
7	Dichotomous key cards for Nigerian timber species	15 sets
8	Wood specimen reference collection (minimum 50 species)	1 set
9	Smartphone-based wood identification app (e.g. XyloTron)	10 Licences
10	Near-infrared (NIR) handheld spectrophotometer	1
11	UV-Visible spectrophotometer (double beam)	2
12	Soxhlet extraction apparatus	6
13	Reflux condenser and round-bottom flasks (assorted)	6
14	Bomb calorimeter	1
15	Muffle furnace (programmable, up to 1200°C)	2
16	Laboratory oven (programmable, forced air circulation)	2
17	Analytical balance (0.0001g resolution)	4
18	Top pan balance (0.01g resolution)	8
19	Digital pH meter (with temperature compensation)	6
20	Thermostatic water bath (multi-position)	4

21	Heating mantle (variable temperature)	6
22	Rotary evaporator (with water bath and condenser)	2
23	Water distillation/deionisation unit	1
24	Fume cupboard/fume hood	2
25	Humidity cabinet (programmable temperature and RH)	1
26	Standard conditioning chamber (23°C, 50% RH)	1

SECTION B: WOOD PHYSICS AND MECHANICAL TESTING LABORATORY

S/NO	ITEM	QUANTITY
1	Universal testing machine (UTM -electronic, min. 50 KN capacity)	1
2	Hardness tester (Brinell or Janka ball type)	1
3	Impact tester (Charpy or Izod type)	1
4	Torsion testing machine	1
5	Creep testing apparatus (dead-load type)	1
6	Stress wave timer (e.g. Metriguard or Fakopp)	1
7	Acoustic emission detector	1
8	Dead weight precision micrometer	4
9	Digital vernier caliper	20
10	Steel rules, try squares, and marking gauges	20 set
11	Electrical resistance moisture meter (pin type)	10
12	Capacitance moisture meter (non-destructive)	5
13	NIR moisture sensor (laboratory bench type)	1
14	Shrinkage and swelling measurement frame	2

15	Water absorption tank (with timing equipment)	2
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SECTION C: WOOD SEASONING AND DRYING LABORATORY

S/NO	ITEM	QUANTITY
1	Laboratory kiln (mini-kiln with programmable controller, humidity and temperature control)	1
2	In-kiln moisture content sensors (electrode type)	4
3	Solar kiln (Bois de Feu or Forrintek design)	1
4	Dehumidification drying unit (small laboratory scale)	1
5	Prong test cutting saw and prong templates	2
6	Dry bulb/wet bulb thermometers (psychrometer)	6
7	Data logger (temperature and humidity, multi-channel)	2

SECTION D: WOOD PRESERVATION AND MODIFICATION LABORATORY

S/NO	ITEM	QUANTITY
1	Pressure impregnation cylinder (small laboratory scale, Bethell/full-cell)	1
2	Vacuum pump (for Lowry/empty-cell process)	1
3	Open tank treatment vessel (for hot and cold open tank)	2
4	Penetration depth measurement tools (core borer, cross-section saw)	2 sets
5	Programmable laboratory oven (up to 250°C)	1
6	Decay test chamber (with humidity and temperature control)	1
7	Fungal culture media preparation equipment (autoclave, petri dishes, inoculation loop)	2 sets

8	Anti-stain chemical applicator (brush/dip tank)	4
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SECTION E: SAWMILLING, PRIMARY CONVERSION, AND WOOD MACHINING WORKSHOP

S/NO	ITEM	QUANTITY
1	Band saw (industrial, with log carriage)	2
2	Circular rip saw	2
3	Cross-cut/radial arm saw	2
4	Thickness planer (surface planer)	2
5	Jointer/surface planer	2
6	Spindle moulder	1
7	Lathe (woodturning)	4
8	Horizontal Mortiser	1
9	Tenoner	1
10	Oscillating spindle sander	2
11	Belt and disc sander	2
12	CNC router (3-axis, with vacuum workholding table)	1
13	CAD/CAM computer workstations (with AutoCAD, Sketch Up, Fusion 360)	30
14	3D scanner (structured light or photogrammetric)	1
15	Wood dust extraction system (central LEV system with bag filter)	1
16	Saw blade sharpening machine (CNC grinding)	1
17	Saw blade tensioning hammer and tensioning rolls	2 Sets
18	Vibration analyser (for machine condition monitoring)	1

SECTION F: WOOD PANEL PRODUCTS LABORATORY

S/NO	ITEM	Quantity
1	Hot press (laboratory scale, heated platens)	2
2	Chip/particle preparation mill (hammer mill or knife ring flaker)	1
3	Particle screening set (wire mesh sieves, assorted sizes)	4 set
4	Resin blender/mixer (laboratory scale)	2
5	Mat former (manual spreading frame)	4
6	Thickness gauge (for pressed panel measurement)	6
7	Internal bond tester (Z-direction tensile)	1
8	Edge crush tester (ECT)	1
9	Box compression tester (BCT)	1
10	Formaldehyde emission desiccator (for E0/E1/E2 classification)	1
11	Peeling lathe (veneer lathe, laboratory scale)	1
12	Veneer dryer (laboratory roller type)	1
13	Glue spreader (laboratory scale)	2
14	Cold press (for ambient temperature bonding)	2
15	Moulded fibre forming mould set (hand-made or machined)	4 set

SECTION G: TIMBER ENGINEERING AND STRUCTURAL TESTING LABORATORY

S/NO	ITEM	QUANTITY
1	Structural testing frame (with hydraulic jack and load cell, min. 100 KN)	1

2	Deflection gauges (dial type and electronic LVDT)	4
3	Strain gauges and data acquisition system	2 Sets
4	Ultrasonic pulse velocity tester (e.g. Pundit or equivalent)	1
5	Fire testing furnace or fire endurance chamber (small scale)	1
6	Protractor and angle measurement tools	10 sets



SECTION H: FURNITURE DESIGN AND FINISHING LABORATORY

S/NO	ITEM	Quantity
1	Spray booth (with ventilation and explosion-proof fan)	1
2	Spray gun set (HVLV type)	6
3	UV curing unit (for UV-cured coatings)	1
4	Gloss meter	2
5	Colour spectrophotometer (portable)	1
6	Orbital sander (electric)	6
7	Sanding block and sandpaper set (60–400 grit)	20 sets
8	KD hardware set (cam locks, confirmat screws, dowels)	10 sets
9	Edge banding machine	1
10	Anthropometric measuring tools (tape measure, sitting box)	5 sets

SECTION I: PULP PREPARATION AND EVALUATION LABORATORY

S/NO	ITEM	Quantity
1	Laboratory autoclave/digester (pulp cooking)	2
2	Pulp disintegrator (standard laboratory type)	2
3	Laboratory Valley beater or PFI mill (refiner)	2
4	Canadian Standard Freeness (CSF) tester	2
5	Laboratory sheet former (TAPPI/British Standard)	4
6	Semi-automatic hydraulic press (for sheet pressing)	2

7	Pulp drying drum	2
8	Kappa number apparatus	2
9	Bauer-McNett fibre classifier (clip sorter and screens)	1
10	Fibre length analyser (optical, e.g. Kajaani FS300)	1
11	Chlorine number determination glassware set	4 sets

SECTION J: PAPER AND BOARD TESTING LABORATORY

S/NO	ITEM	Quantity
1	Tensile strength tester (electronic, e.g. Lloyd or Instron)	1
2	Bursting strength tester (Mullen-type, digital)	2
3	Tearing strength tester (Elmendorf-type)	2
4	Stiffness tester (Taber or LandW-type)	1
5	Endurance fold tester (MIT-type)	1
6	Smoothness and porosity tester (Bendtsen-type)	1
7	Surface roughness tester (Parker Print-Surf)	1
8	Opacity/brightness tester (Elrepho spectrophotometer)	1
9	Dead weight precision micrometer	4
10	Guillotine (motorised paper cutter)	2
11	Cobb size tester	2
12	WVTR testing apparatus (water vapour transmission rate)	1
13	Grease resistance test kit (Kit test method)	2

14	Standard conditioning chamber (23°C, 50% RH)	1
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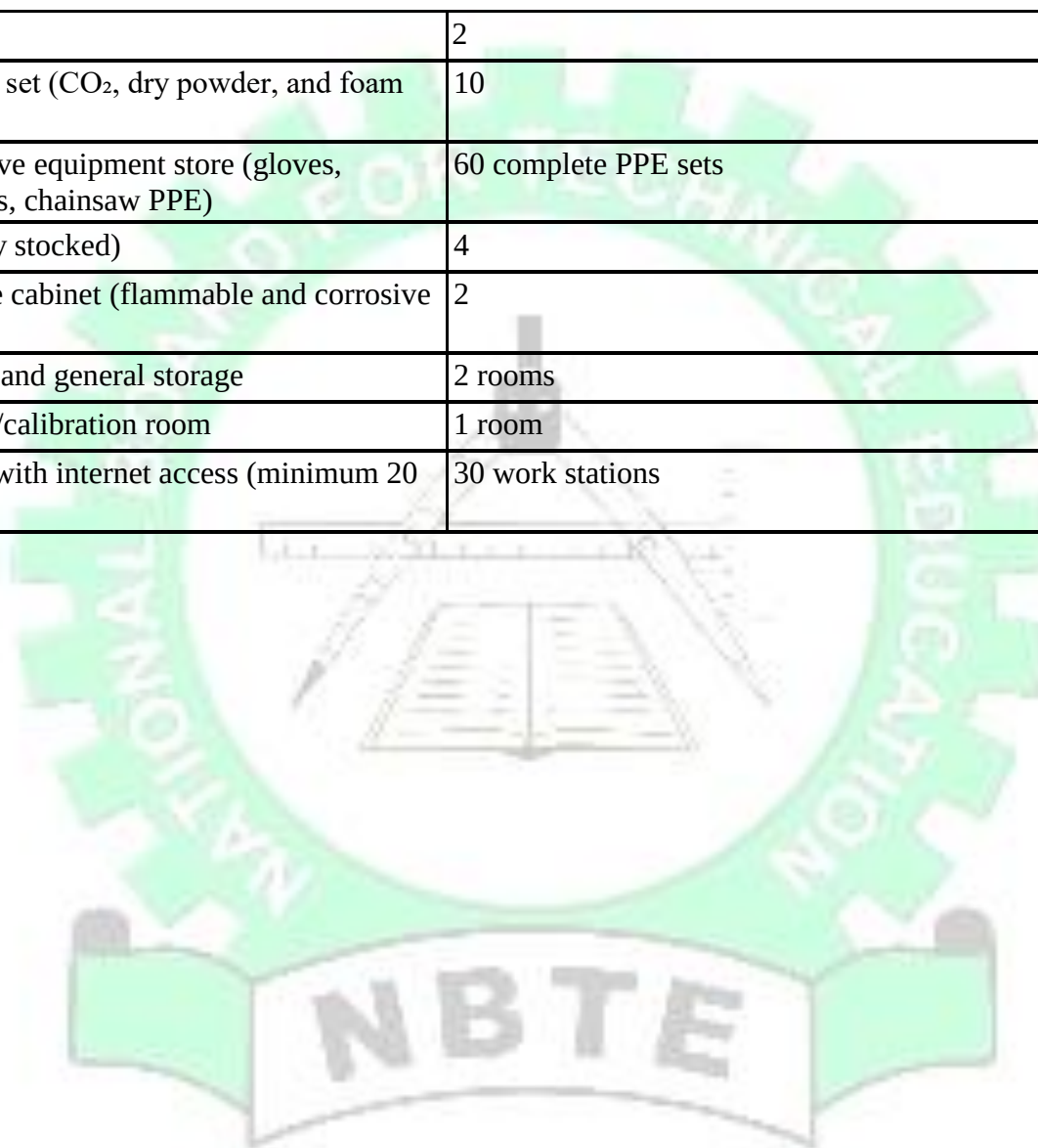
SECTION K: CHEMICAL AND ANALYTICAL LABORATORY (SHARED)

S/NO	ITEM	Quantity
1	COD determination apparatus (reflux)	2
2	BOD incubator and apparatus (5-day test)	2
3	Turbidity meter (nephelometer)	2
4	Dissolved oxygen meter	2
5	Digital conductivity meter	2
6	High-speed centrifuge (minimum 10,000 rpm)	2
7	Ultrasonic probe sonicator	1
8	High-pressure homogeniser	1
9	Zeta potential analyser	1
10	Laboratory flotation deinking cell	1
11	Disperger (stickies dispersion)	1
12	UV lamp and TLC equipment	2
13	Blender (commercial heavy duty laboratory type)	4
14	Heating mantle (variable temperature)	4
15	Rotary evaporator (with condenser)	2

SECTION L: INFRASTRUCTURE AND SAFETY

S/NO	ITEM	Quantity
1	Fume cupboard/fume hood (ducted)	2
2	Emergency eyewash station	4

3	Safety shower	2
4	Fire extinguisher set (CO ₂ , dry powder, and foam types)	10
5	Personal protective equipment store (gloves, goggles, lab coats, chainsaw PPE)	60 complete PPE sets
6	First aid kit (fully stocked)	4
7	Chemical storage cabinet (flammable and corrosive segregation)	2
8	Laboratory store and general storage	2 rooms
9	Instrument room/calibration room	1 room
10	Computer room with internet access (minimum 20 workstations)	30 work stations



LIST OF WORKSHOP PARTICIPANTS

S/N	NAME	CONTACT ADDRESS	E-MAIL
1.	Prof Idris M. Bugaje	Executive Secretary National Board for Technical Education	es@nbte.gov.ng
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