



NATIONAL BOARD FOR TECHNICAL EDUCATION

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

NATIONAL DIPLOMA

IN

**HYDROLOGY AND WATER RESOURCES
MANAGEMENT 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 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.

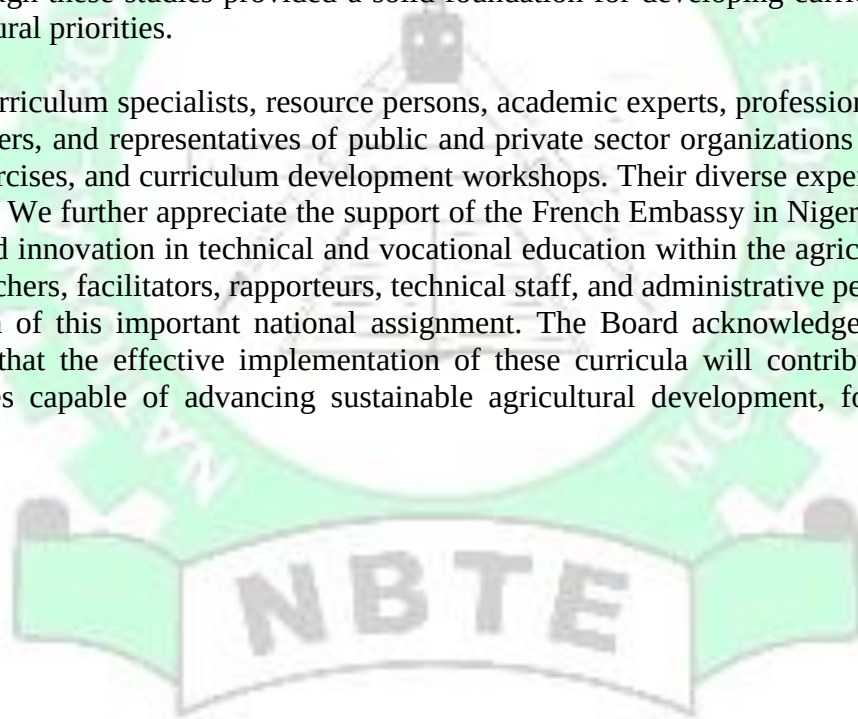
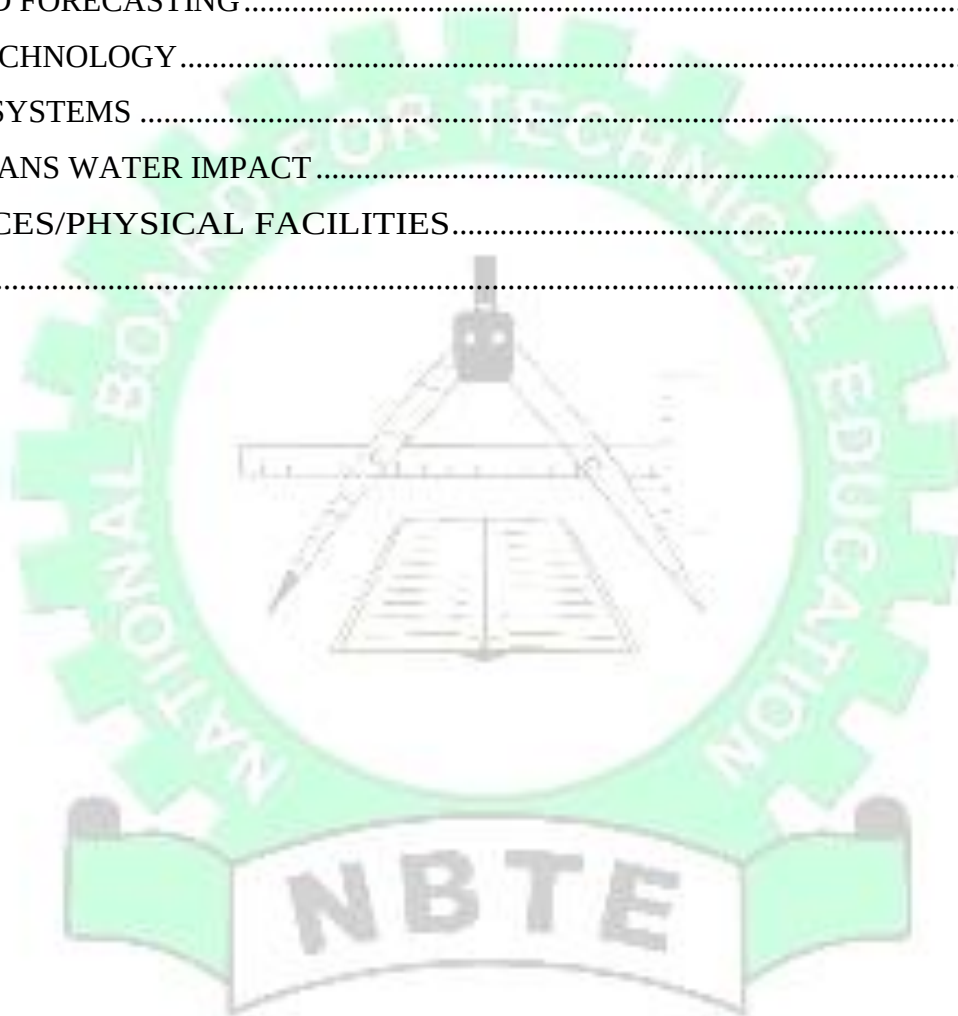


TABLE OF CONTENTS

PREFACE	ii
ACKNOWLEDGEMENT	iii
GENERAL INFORMATION	vi
CURRICULUM TABLES	xii
YEAR I - SEMESTER I	1
INTRODUCTION TO HYDROMETRY	2
HYDRO-CHEMISTRY	8
BASIC HYDROLOGY	18
PHYSICAL GEOGRAPHY AND PHOTO INTERPRETATION	26
YEAR I SEMESTER II	33
HYDROLOGY AND HYDRO-STATISTICS	34
BASIC HYDRAULICS	46
GIS AND REMOTE SENSING	52
INTRODUCTION TO HYDROMETEOROLOGY	58
INTRODUCTION TO HYDROGEOLOGY	64
BASIC PRINCIPLE OF SURVEY	69
YEAR II - SEMESTER I	76
WATER RESOURCES MANAGEMENT I	77
HYDROLOGICAL DATA COLLECTION, PROCESSING AND FIELD METHODS	85
WATERSHED HYDROLOGY AND CATCHMENT MANAGEMENT	95
WATER QUALITY ASSESSMENT AND POLLUTION CONTROL	105

YEAR II - SEMESTER II.....	111
WATER RESOURCES MANAGEMENT II.....	112
HYDROLOGICAL ANALYSIS AND FORECASTING	121
WATER SUPPLY AND WASTE TECHNOLOGY	127
DIGITAL WATER MONITORING SYSTEMS	134
SMART CLIMATE VARIABILITY ANS WATER IMPACT	139
LIST OF MINIMUM RESOURCES/PHYSICAL FACILITIES.....	145
LIST OF PARTICIPANTS.....	149



GENERAL INFORMATION**1.0 TITLE OF THE PROGRAMME**

The title of the programme is National Diploma (ND) in Hydrology and Water Resources Management Technology

2.0 PROGRAMME GOAL

The National Diploma (ND) in Hydrology and Water Resources Management Technology is aimed at producing diplomates with knowledge and skills to effectively manage the water resources potentials of the Nigerian economy. It would enable them acquire technological and professional skills necessary for employment and job creation in various areas of hydrology and water resources management.

3.0 OBJECTIVES OF THE PROGRAMME

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

- i. Analyze hydrological processes and apply water resources management principles for sediment and water quality assessment.
- ii. Maintain, organize, and manage data related to dams, reservoirs, surface water, and groundwater resources.
- iii. Apply conventional and digital instrumentation, computer programming, and data processing techniques in water resources monitoring.
- iv. Assess and predict geomorphological changes within drainage basins to support planning and decision-making.
- v. Manage and interpret hydrological data for flood forecasting, drought prediction, and disaster risk management.
- vi. Operate, calibrate, and maintain meteorological and hydrological equipment for data collection and hydrologic structure design.
- vii. Evaluate groundwater flow, recharge, extraction, and water quality, and conduct pumping tests using standard procedures.
- viii. Prepare and manage water resources accounts for river basins.
- ix. Operate, maintain, and monitor streamflow gauging stations and conduct hydrological observations using appropriate techniques.

4.0 ENTRY REQUIREMENTS

The minimum entry requirements for admission into the ND Hydrology and Water Resources Management Technology programme are:

- i. Four (4) O'Level credit passes in relevant subjects, including Mathematics, Agriculture Science or biology, Physics or Geography and any one relevant science subject. A pass in English Language is mandatory.
- ii. Evidence of registration with JAMB.

5.0 STRUCTURE AND DURATION OF THE PROGRAMME

The National Diploma in Hydrology and Water Resources Management Technology programme is structured to last for two (2) years (four semesters) of classroom work, laboratory practicals, field studies and workshop practices.

Each semester shall consist of 17 weeks made up as follows:

- 15 contact weeks of teaching (lectures, practicals and fieldwork);
- 2 weeks for registration and examinations.

6.0 CURRICULUM STRUCTURE

The curriculum of the ND Hydrology and Water Resources Management Technology Programme consists of four main components:

- a. General Studies/General Education Courses
- b. Foundation Courses
- c. Professional Courses
- d. Students' Industrial Work Experience Scheme (SIWES)

7.0 STAFFING REQUIREMENTS

7.1 Core Teaching Staff

A minimum of four (4) core teaching staff who should possess at least HND or B.Sc. or equivalent qualification in Hydrology and Water Resources Management Technology, Water Resources, Environmental, Engineering, Geology or related disciplines

7.2 Technical Staff

The technical staff:

i. Technologist

Technologist is a senior technical staff responsible for supervising practical and laboratory activities in the department. The technologist operates, manages, and maintains laboratory and field equipment, assists lecturers during practical sessions, and supports research and field studies in wildlife and ecotourism. There has to be a relevant Technologist attached to each training facility.

ii. Technician

Technician assists in carrying out technical and practical operations within the department. The technician helps in preparing equipment and materials for practical classes, maintaining tools and facilities, and supporting students and lecturers during laboratory and field activities. There has to be a relevant Technician attached to each training facility.

iii. Field Assistant

Field Assistant supports outdoor and field operations such as wildlife surveys, conservation activities, habitat monitoring, camping exercises, and data collection. The field assistant also helps in handling field equipment and ensuring smooth coordination of field trips and excursions.

7.3 Headship of The Department

The Head of Department shall possess at least a HND/First Degree and Master's Degree in Hydrology and Water Resources Management Technology, Water Resources, Environmental, Engineering, Geology or a related discipline. He or she shall not be less than the rank of a Senior Lecturer shall be registered with a relevant Professional Body and shall have a minimum of twelve (12) years' experience in both academic and industry.

8.0 CERTIFICATION

A diplomate of this Programme shall be awarded the National Diploma (ND) in Hydrology and Water Resources Management Technology

9.0 CONDITIONS FOR THE AWARD OF ND

Institutions offering accredited programmes will award the National Diploma to candidates who successfully completed the programme after passing prescribed coursework, examinations, diploma project and the Students Industrial Work Experience Scheme (SIWES). Such candidates should have completed a minimum of between 72 and 80 semester credit units depending on the programme.

9.1 Grading of Courses: 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	0.0

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
CGPA 2.00-2.49	Pass

10.0 ACCREDITATION

The National Diploma (ND) in Hydrology and Water Resources Management Technology programme shall be accredited by NBTE before the diplomates can be awarded the diploma certificate. Details about the process of accrediting a programme for the award of the ND are available from the Executive Secretary, National Board for Technical Education (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.

12.1 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.

13.0 GUIDELINES ON SIWES PROGRAMME

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

14.1 Responsibility for placement of Students.

- a. Institution offering the ND programme shall arrange to place the students in relevant industries. By the end of second semester of the first academic session, six copies of the master list showing where each student has been placed shall be submitted to the Executive Secretary, NBTE, who shall, in turn authenticate the list and forward it to the Industrial Training Fund, Jos.
- b. The Placement Officer should discuss and agree with the various industries on the following:
 - i. A task inventory of what the student is expected to experience during the period of attachment. It may be wise to adopt the one already approved for each field by the industry-based supervisor.
 - ii. The evaluation of the student by the industry-based supervisor and the institution-based supervisor.
 - iii. The final grading of the student during the period of attachment should be weighted more on the evaluation by industry-based supervisor.

14.2 Evaluation of Student during the SIWES

In the evaluation of the student, cognisance should be taken of the following items:

- i. Punctuality
- ii. Attendance
- iii. General attitude to work
- iv. Routine report of weekly activities in the logbook
- v. Respect for authority
- vi. Interest in the field/technical area
- vii. Technical competence as a potential technician in his field.

14.3 Grading of SIWES

To ensure uniformity of grading scales, the institution should ensure that the uniform grading of students work agreed to by all TVET Institutions is adopted.

14.4 The Institution based Supervisor

The institution-based supervisor should initial the log book during each visit. This will enable him to check and determine to what extent the objectives of the scheme are being met and to assist students having any problems regarding the specific tasks given to them by their industry-based supervisor.

14.5 Frequency of visit

Institutions should ensure that students placed on the attachment are visited within one month of their placement. Other visits shall be arranged so that:

- i. There is another visit six weeks after the first visit; and
- ii. A final visit in the last month of the attachment.

14.6 Stipend for Students in SIWES

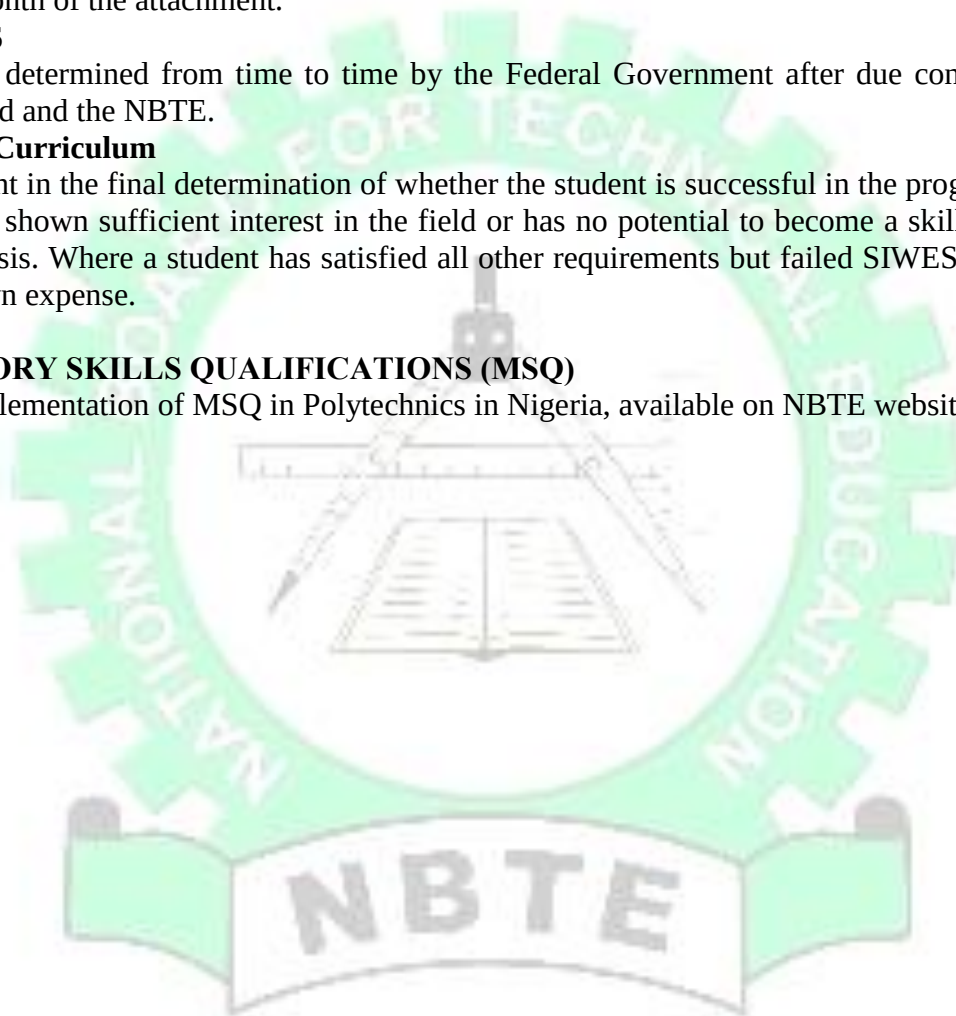
The rate of stipend payable shall be determined from time to time by the Federal Government after due consultation with the Federal Ministry of Education, the Industrial Training fund and the NBTE.

14.7 SIWES as a component of the Curriculum

The completion of SIWES is important in the final determination of whether the student is successful in the programme or not. Failure in the SIWES is an indication that the student has not shown sufficient interest in the field or has no potential to become a skilled technician in his field. The SIWES should be graded on a **fail** or **pass** basis. Where a student has satisfied all other requirements but failed SIWES, she/he may only be allowed to repeat another four months SIWES at his own expense.

15.0 GUIDELINES ON MANDATORY SKILLS QUALIFICATIONS (MSQ)

Please, see the Guidelines for the Implementation of MSQ in Polytechnics in Nigeria, available on NBTE website (web.nbte.gov.ng/downloads).



CURRICULUM TABLES

YEAR I SEMESTER I

S/N	COURSE CODE	COURSE TITLE	L	T	P	CH	CU
1.	GNS 101	Use of English I	2	0	0	2	2
2.	GNS 111	Citizenship Education I	2	0	0	2	2
3.	MSQ 111	Mandatory Skills Qualification	1	0	1	2	2
4.	COM 111	Introduction to Computing	2	0	2	4	4
5.	MEC 111	Technical Drawing	1	0	3	4	4
6.	MTH 112	Algebra and Elementary Trigonometry	2	0	0	2	2
7.	HWR 111	Introduction to Hydrometry	1	0	3	4	4
8.	HWR 112	Hydro-Chemistry	1	0	3	4	4
9.	HWR 113	Basic Hydrology	1	0	3	4	4
10.	HWR 114	Physical Geography and Photo Interpretation	1	0	3	4	4
TOTAL			14	0	18	32	32

YEAR I SEMESTER II

S/N	COURSE CODE	COURSE TITLE	L	T	P	CH	CU
1.	GNS 102	Communication in English I	2	0	0	2	2
2.	GNS 121	Citizenship Education II	2	0	0	2	2
3.	ENT 126	Introduction to Entrepreneurship I	2	0	1	3	3
4.	HWR 121	Hydrology and Hydro-statistics	1	0	3	4	4
5.	HWR 122	Basic Hydraulics	1	0	3	4	4
6.	HWR 123	GIS and Remote Sensing for Water Resources Management	1	0	3	4	4
7.	HWR 124	Introduction to Hydrometeorology	1	0	3	4	4
8.	HWR 125	Introduction to Hydrogeology	1	0	3	4	4
9.	HWR 126	Basic Principles of Surveying	1	0	3	4	4
TOTAL			12	0	19	31	31

YEAR II - SEMESTER I

S/N	COURSE CODE	COURSE TITLE	L	T	P	CH	CU
1.	GNS 201	Use of English II	2	0	0	2	2
2.	ENT 216	Introduction to Entrepreneurship II	2	0	1	3	3
3.	AGR 201	Research Methods and Experimental Design	1	0	1	2	2
4.	HWR 211	Water Resources Management I	1	0	3	4	4
5.	HWR 212	Hydrological Data Collection, Processing and Field Methods	1	0	3	4	4
6.	HWR 213	Watershed Hydrology and Catchment Management	1	0	3	4	4
7.	HWR 214	Water Quality Assessment and Pollution Control	1	0	3	4	4
8.	HWR 215	Field Trip	0	0	3	3	3
9.	HWR 216	Students Industrial Work Experience Scheme (SIWES)	0	0	4	4	4
TOTAL			9	0	21	30	30

YEAR II - SEMESTER II

S/N	COURSE CODE	COURSE TITLE	L	T	P	CH	CU
1.	GNS 202	Communication in English II	2	0	0	2	2
2.	HWR 221	Water Resources Management II	1	0	3	4	4
3.	HWR 222	Hydrological Analysis and Forecasting	1	0	3	4	4
4.	HWR 223	Water Supply and Waste Technology	1	0	3	4	4
5.	HWR 224	Digital Water Monitoring Systems	1	0	3	4	4
6.	HWR 225	Smart Climate Variability and Water Impact	1	0	1	2	2
7.	HWR 226	Project	0	0	4	4	4
TOTAL			7	0	17	24	24

L = Lectures (hours/week)

P = Practical (hours/week)

T = Tutorial (hours/week)

CH = Contact Hour (Hours/week)

CU = Credit Unit



INTRODUCTION TO HYDROMETRY

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY		
COURSE: INTRODUCTION TO HYDROMETRY	COURSE CODE: HWR 111	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: I	PRE-REQUISITE:	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills of River Gauging Measurement		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the installation and maintenance of gauging stations; 2.0 Understand water level measurements and installation procedures; 3.0 Understand principles of discharge measurement and estimations; 4.0 Understand the principles of discharge computation and discharge rating curve; 5.0 Understand the basics of gauging station management; 6.0 Know the basic concepts of sediment discharge and water quality measurements.		

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY						
COURSE TITLE: INTRODUCTION TO HYDROLOGY AND WATER RESOURCES MANAGEMENT			COURSE CODE: HWR 111		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: I 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 of River Gauging Measurement						
General Objective 1.0: Understand the installation and maintenance of gauging stations						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Explain Hydrometry 1.2 Describe features and components of a gauging station 1.3 Describe the criteria used in selecting gauging station. 1.4 Describe types of channel conditions.	• Explain Hydrometry • Discuss features and components of a gauging station • Discuss the criteria used in selecting gauging station. • Explain types of channel conditions.	Textbooks, Journals Computer Projector Whiteboard Marker Internet	• Identify the components of gauging stations • Identify the criteria used in selecting gauging station.	Guide Students to: • Identify components of gauging stations • Identify the criteria used in selecting gauging station.	Current Meter Acoustic Doppler Current Profiler Float Method Weirs Flumes Electromagnetic Flow Meter Stage Recorder Ultrasonic (Acoustic) Flow Meter
General Objective 2.0: Understand water level measurements and installation procedures.						
4-6	2.1 Explain water level/stage 2.2 Describe types of water level	• Explain water level/stage • Explain types of water level	Textbooks, Journals Computer Projector	• Identify various water level instruments • Carry out	Guide students to: • Identify various water level instruments • Carry out	Water level instruments

	instruments. 2.3 Describe the usage of water level instruments. 2.4 Describe the maintenance of water level instruments. 2.5 Explain the installation of the various water level instruments. 2.6 Explain errors affecting water level measurements.	instruments. • Discuss the usage of water level instruments. • Discuss the maintenance of water level instruments • Discuss the installation of the various water level instruments. • Explain errors affecting water level measurements.	Whiteboard Marker Internet	installation of water level gauges. • Carry out maintenance of water level gauges • Keep a record of water level readings.	installation of water level gauges. • Carry out maintenance of water level gauges • Keep a record of water level readings.	
General Objective 3.0: Understand principles of discharge measurement and estimations.						
7-9	3.1 Explain the terms: discharge, stream flow, and runoff. 3.2 Explain the different methods of discharge measurement. 3.3 Describe the different instruments needed for discharge measurement. 3.4 Describe methods of velocity measurement.	• Explain the terms: discharge, stream flow, and runoff. • Explain the different methods of discharge measurement. • Discuss the different instruments needed for discharge measurement. • Discuss methods of velocity measurement • Explain the different	Textbooks, Journals Computer Projector Whiteboard Marker Internet	• Identify the different types of current meters • Carry out outdoor activities to measure discharge by direct and indirect methods • Carry out the maintenance of current meters. • Convert water	Guide students to: • Identify the different types of current meters • Carry out outdoor activities to measure discharge by direct and indirect methods • Carry out the maintenance of current meters. • Convert water levels record to discharge record.	Rainfall gauges of different types, Water level gauges, Current meter, Float and Typical solution, Acoustic Doppler Current Profiler, Float Method Weirs, Flumes, Electromagnetic Flow Meter, Stage Recorder,

	3.5 Explain the different indirect methods of discharge measurement.	indirect methods of discharge measurement		levels record to discharge record.		Ultrasonic (Acoustic) Flow Meter, Pitot tube.
	3.6 Explain the errors affecting discharge measurements	Explain the errors affecting discharge measurements				

General Objective 4.0: Understand the principles of discharge computation and discharge rating curve.

10-11	4.1 Explain the different methods of discharge computation, e.g. arithmetic and graphical method etc 4.2 Explain stage-discharge relationship 4.3 Explain the construction of discharge rating curve 4.4 Explain extension of stage-discharge curve 4.5 Describe the factors affecting stage-discharge relationship	- Explain the different methods of discharge computation, e.g. arithmetic and graphical method etc - Discuss stage-discharge relationship - Discuss the construction of discharge rating curve - Explain extension of stage-discharge curve - Describe the factors affecting stage-discharge relationship	Textbooks, Journals, Computer, Projector, Whiteboard, Marker, Internet	- Develop stage-discharge curve - Compute the discharge of a river - Plot discharge rating curve using graphical method.	Guide students to: - Develop stage-discharge curve - Compute the discharge of a river - Illustrate the construction of discharge rating curve using graphical method.	Computer and other related software
-------	--	---	--	--	--	-------------------------------------

General Objective 5.0: Understand the basics of gauging station management.

12-13	5.1 Describe conditions affecting gauging station stability. 5.2 Explain the factors affecting level checks 5.3 Explain the factors affecting discharge measurements. 5.4 Describe station management plans.	• Explain conditions affecting gauging station stability. • Explain the factors affecting level checks • Explain the factors affecting discharge measurements. • Describe station management plans.	Textbooks, Journals, Computer Projector, Whiteboard, Marker, Internet	• Identify the factors affecting level checks • Identify the factors affecting discharge measurements. • Draw a gauging station management plan.	Guide students to: • Identify the factors affecting level checks • Identify the factors affecting discharge measurements. • Draw a gauging station management plan.	Staff gauge Baord Automatic gauge Pressure transducer Ultrasonic water level sensor Float gauge
General Objective 6.0: Know the basic concepts of sediment discharge and water quality measurements						
14-15	6.1 Explain sediment production in a river channel/water reservoir. 6.2 Outline the factors affecting sediment production. 6.3 Explain various methods of sediment measurement. 6.4 Explain determination of daily mean sediment concentration.	• Explain sediment production in a river channel/water reservoir. • Explain the factors affecting sediment production. • Explain various methods of sediment measurement. • Explain determination of daily mean sediment concentration.	Textbooks, Journals, Computer Projector, Whiteboard, Marker, Internet	• Carry out water sampling from a given river channel • Compute sediment concentration using various methods. • Draw sediment-rating curve.	Guide students to: • Carry out water sampling from a given river channel • Compute sediment concentration using various methods. • Draw sediment-rating curve.	Sampling bottles, sediment samples, Sediment sampler, PH Meter Water sample bottles.
COURSE ASSESSMENT: Course work 10%						

Test/Assignments 10%
Practical 40%
Examination 40% = 100%



HYDRO-CHEMISTRY

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY		
COURSE TITLE: HYDRO-CHEMISTRY	COURSE CODE: HWR 112	CONTACT HOURS: 3 HOURS/WEEK
	CREDIT UNIT: 3	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: I	PRE-REQUISITE:	PRACTICAL: 2 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills in hydrochemical analysis and environmental monitoring.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the Analytical Process and Quality Assurance in Hydrochemistry; 2.0 Understand Separation Techniques and Instrumental Analytical Methods; 3.0 Understand the Statistical Analysis of Experimental Data; 4.0 Understand Titrimetric Analysis and its Applications; 5.0 Understand the Principles and Applications of Gravimetric Analysis; 6.0 Understand Instrumental Methods for Hydrochemical Analysis.		

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY						
COURSE TITLE: HYDRO-CHEMISTRY			COURSE CODE: HWR 112		CONTACT HOURS: 3 HOURS/WEEK	
			CREDIT UNIT: 3		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: I			PRE-REQUISITE:		PRACTICAL: 2 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills in hydrochemical analysis and environmental monitoring.						
General Objective 1.0: Understand the Analytical Process and quality assurance in hydrochemistry						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Define analytical chemistry and hydrochemistry. 1.2 Explain the importance of hydrochemistry in water resources management. 1.3 Explain laboratory organization and safety procedures. 1.4 Describe common laboratory hazards and safety measures. 1.5 Explain laboratory ethics and good laboratory practices (GLP).	• Explain analytical chemistry and hydrochemistry. • Explain the importance of hydrochemistry in water resources management. • Explain laboratory organization and safety procedures. • Describe common laboratory hazards and safety measures. • Explain laboratory ethics and good laboratory practices	Whiteboard Projector, Computer Internet Safety Manual, Water Sampling Manual, Multimedia Resources Laboratory Equipment, Charts Calibration Standards,	• Identify laboratory equipment and safety devices. • Identify common laboratory hazards and safety measures. • Demonstrate proper laboratory conduct. • Collect representative water samples from different sources. • Prepare samples	Guide students to: • Conduct laboratory orientation and safety demonstration. • Demonstrate field sampling procedures. • Demonstrate filtration and preservation procedures. • Perform quality control checks using standard solutions. • Perform instrument	Laboratory, PPE, Fire Extinguisher, First Aid Box Sampling Bottles, Cooler Box, Labels, GPS Filter Papers, Funnels, Reagents Water Sampling Manual, Analytical Balance, Standards Standard Solutions, Glassware

1.6 Describe representative sampling techniques. 1.7 Explain sample preservation and transportation methods. 1.8 Outline sources of sampling errors 1.9 Explain sample preparation methods. 1.10 Describe filtration, digestion and preservation techniques. 1.11 Explain chain-of-custody procedures. 1.12 Define accuracy, precision, sensitivity and selectivity. 1.13 Explain detection limit and quantification limit. 1.14 Explain quality assurance and quality control (QA/QC).	(GLP). • Explain representative sampling techniques. • Explain sample preservation and transportation methods. • Explain sources of sampling errors • Explain sample preparation methods. • Discuss filtration, digestion and preservation techniques. • Explain chain-of-custody procedures. • Discuss accuracy, precision, sensitivity and selectivity. • Explain detection limit and quantification limit. Discuss quality assurance and quality control (QA/QC). • Explain calibration		for analysis. • Evaluate analytical performance. • Construct calibration curves. • Record findings • Report findings	calibration exercises. • Record findings • Report findings	Laboratory Records, Computers
--	---	--	--	--	--------------------------------------

	1.15 Explain calibration methods. 1.16 Differentiate between external standards, internal standards and standard addition methods. 1.17 Explain calibration curves. 1.18 Explain data recording and laboratory documentation. 1.19 Explain uncertainty in measurement.	methods. • Explain the differences between external standards, internal standards and standard addition methods. • Explain calibration curves. • Explain data recording and laboratory documentation. • Explain uncertainty in measurement.				
General Objective 2.0: Understand Separation Techniques and Instrumental Analytical Methods						
4-6	2.1 Define chromatography. Explain adsorption and partition chromatography. 2.2 Explain paper chromatography and silica gel thin-layer chromatography. 2.3 Explain column chromatography over silica gel.	• Define chromatography. Explain adsorption and partition chromatography. • Explain paper chromatography and silica gel thin-layer chromatography. • Explain column chromatography over silica gel.	Charts, Projector Chromatographic Columns Extraction Apparatus Multimedia Presentations	• Separate simple mixtures using chromatography. • Perform simple separation experiments. • Perform extraction experiments. • Observe the operation of advanced instruments.	Guide students to: • Demonstrate chromatographic separation. • Supervise laboratory exercises. • Guide practical sessions. • Demonstrate available instruments.	TLC Plates, Solvents Columns, Resins Separating Funnel, Solvents HPLC/GC Videos or Instruments

	2.4 Explain ion exchange chromatography. 2.5 Discuss applications in water analysis. 2.6 Explain solvent extraction principles. 2.7 Explain liquid-liquid extraction. 2.8 Discuss Soxhlet extraction. 2.9 Explain electrophoresis electrophoretic mobility and Stokes equation electroosmosis and apparent mobility 2.10 Explain HPLC principles. normal phase HPLC and reverse phase HPLC discuss retention time, peak shape, peak broadening and peak 2.11 Explain Gas Chromatography applications.	• Explain ion exchange chromatography. • Discuss applications in water analysis. • Explain solvent extraction principles. • Explain liquid-liquid extraction. • Discuss Soxhlet extraction. • Explain electrophoresis electrophoretic mobility and Stokes equation electroosmosis and apparent mobility • Explain HPLC principles. normal phase HPLC and reverse phase HPLC • Discuss retention time, peak shape, peak broadening and peak • Explain Gas Chromatography applications.				
--	---	---	--	--	--	--

General Objective 3.0: Understand the Statistical Analysis of Experimental Data						
7-8	3.1 Define accuracy and precision 3.2 Explain the two methods: Absolute error and Relative error. 3.3 Explain the main classes of error: Systematic (determinate) errors: Personal or operational errors, Instrumental errors, Reagent errors, Method errors, Additive errors, Proportional errors. Random (indeterminate) errors, Gross errors 3.4 Explain methods of minimizing analytical errors 3.5 Calculate propagated errors 3.6 Explain significant figures 3.7 Explain significant figures in analytical results.	• Explain accuracy and precision • Explain the two methods: Absolute error and Relative error. • Explain the main classes of error: – Systematic (determinate) errors: Personal or operational errors, Instrumental errors, Reagent errors, Method errors, Additive errors, Proportional errors. – Random (indeterminate) errors, – Gross errors • Explain methods of minimizing analytical errors • Calculate propagated errors • Explain significant figures • Explain significant figures in analytical results.	Whiteboard, Calculator Statistical Tables Projector, Charts Charts, Laboratory Manual	• Analyze selected water quality parameters using titrimetric methods • Calculate analytical errors. • Analyze laboratory data. • Apply statistical tests to analytical data.	Guide students to: • Analyze selected water quality parameters using titrimetric methods • Calculate analytical errors. • Analyze laboratory data. • Apply statistical tests to analytical data.	Calculators Statistical Tables, Calculators Statistical Software, Calculators Demonstrate laboratory procedures

	3.8 Explain mean, median, mode, variance, standard deviation, relative standard deviation, and the range. 3.9 Explain confidence limits. 3.10 Explain normal distribution (Gaussian distribution). 3.11 Explain Student's t-test. 3.12 Explain F-test and Chi-square test.	• Explain mean, median, mode, variance, standard deviation, relative standard deviation, and the range. • Explain confidence limits. • Explain normal distribution (Gaussian distribution). • Explain Student's t-test. • Explain F-test and Chi-square test.				
General Objective 4.0: Understand Titrimetric Analysis and its Applications						
9-10	4.1 Define titrimetric analysis. 4.2 Describe the basic principles if titrimetric analysis 4.3 Explain the determination of end points in titration 4.4 Explain the use of indicators in titrimetric analysis 4.5 Explain the use of pH-metric and conductometric	• Explain titrimetric analysis. • Discuss the basic principles if titrimetric analysis • Discuss the determination of end points in titration • Explain the use of indicators in titrimetric analysis • Explain the use of pH-metric and	Glassware, Indicators Whiteboard, Projector	• Perform acid-base titration. • Determine hardness and chloride concentration	Guide students to: • Perform acid-base titration. • Determine hardness and chloride concentration	Burettes, Pipettes, Indicators EDTA, Silver Nitrate Reagents, Glassware

	methods 4.6 Explain different types of titrations: - Acid–Base Titration - Oxidation-Reduction (REDOX) Titration - Precipitation titration - Complexometric titration	conductometric methods - Discuss different types of titrations: - Acid–Base Titration - Oxidation-Reduction (REDOX) Titration - Precipitation titration - Complexometric titration				
General Objective 5.0: Understand the Principles and Applications of Gravimetric Analysis						
11-12	5.1 Define gravimetric analysis. 5.2 Explain precipitation gravimetry. 5.3 Explain co-precipitation, post-precipitation, and digestion. 5.4 Explain applications of gravimetric analysis in water quality studies. 5.5 Explain determination of TSS, TDS and	- Explain gravimetric analysis. - Explain precipitation gravimetry. - Explain co-precipitation, post-precipitation, and digestion. - Explain applications of gravimetric analysis in water quality studies. - Explain determination of TSS, TDS and	Whiteboard, Charts Water Quality Standards	- Determine suspended solids. - Determine TSS and TDS in water samples	Guide students to: - Demonstrate gravimetric procedures. - Conduct laboratory exercises.	Drying Oven, Balance Filtration Apparatus, Oven

	salinity	salinity				
General Objective 6.0: Understand Instrumental Methods for Hydrochemical Analysis						
13-15	6.1 Explain the principles and classification of instrumental methods used in hydrochemical analysis. 6.2 Explain the operating principles of spectroscopic, electrochemical, and chromatographic techniques used in hydrochemical analysis. 6.3 Explain quality assurance, quality control, calibration, and laboratory safety in instrumental hydrochemical analysis.	• Explain the principles and classification of instrumental methods used in hydrochemical analysis. • Explain the operating principles of spectroscopic, electrochemical, and chromatographic techniques used in hydrochemical analysis. • Explain quality assurance, quality control, calibration, and laboratory safety in instrumental hydrochemical analysis.	Whiteboard, Calc Charts, Laboratory Manual	• Operate spectroscopic instruments to analyse selected hydrochemical parameters in water samples. • Use electrochemical instruments to determine pH, electrical conductivity, dissolved oxygen, and oxidation-reduction potential of water samples. • Perform chromatographic analysis of water samples using appropriate techniques. • Calibrate analytical instruments and perform quality assurance and quality control procedures.	Guide students to: • Operate spectroscopic instruments to analyse selected hydrochemical parameters in water samples. • Use electrochemical instruments to determine pH, electrical conductivity, dissolved oxygen, and oxidation-reduction potential of water samples. • Perform chromatographic analysis of water samples using appropriate techniques. • Calibrate analytical instruments and perform quality assurance and quality control procedures. • Analyse	Water Samples, Instruments Computers, Data Sheets

				• Analyse hydrochemical data obtained from instrumental methods. • Interpret hydrochemical data obtained from instrumental methods. • Report hydrochemical data obtained from instrumental methods.	hydrochemical data obtained from instrumental methods. • Interpret hydrochemical data obtained from instrumental methods. • Report hydrochemical data obtained from instrumental methods.	
COURSE ASSESSMENT: Course work 10% Test/Assignments 10% Practical 40% Examination 40% = 100%						

BASIC HYDROLOGY

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY		
COURSE TITLE: BASIC HYDROLOGY	COURSE CODE: HWR 113	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: I	PRE-REQUISITE:	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills of hydrological processes, measure and interpret hydrological data		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the definition, scope and field of applications of hydrology; 2.0 Understand the Hydrological cycle and the mechanisms that drive it; 3.0 Understand the concept of surface runoff; 4.0 Understand Precipitation and the mechanisms that drive it; 5.0 Understand the unit of hydrograph; 6.0 Understand the measurement of stream flow; 7.0 Understand the concept of ground water, types and ground water storage and measurement; 8.0 Understand flood estimation and control.		

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY						
COURSE TITLE: BASIC HYDROLOGY			COURSE CODE: HWR 113		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: I 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 of hydrological processes, measure and interpret hydrological data						
General Objective 1.0: Understand the meaning, scope and field of applications of hydrology						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1	1.1 Define and outline the branches and scope of hydrology 1.2 Outline the field of applications of hydrology, the techniques of hydrology and the problems of applied hydrology 1.3 Outline the brief history of the development of the field of hydrology	- Explain and outline the branches and scope of hydrology - Outline the field of applications of hydrology, the techniques of hydrology and the problems of applied hydrology - Outline the brief history of the development of the field of hydrology	Charts, White board, Marker, Duster, Laptop Video tabs , Overhead projector			

	1.4 Discuss the role of the hydrologist in integrated development	Discuss the role of the hydrologist in integrated development				
General Objective 2.0: Understand the Hydrological cycle and the mechanisms that drive it						
2-3	2.1 Explain the concept of hydrological cycle using diagram. 2.2 Explain the components of the hydrological cycle. 2.3 Describe the mechanisms that drive the hydrological cycle and explain the concept of the hydrological equation. 2.4 Outline the relevance of the hydrological cycle to the study of hydrology	- Explain the concept of hydrological cycle using diagram. - Explain the components of the hydrological cycle. - Discuss the mechanisms that drive the hydrological cycle and explain the concept of the hydrological equation. - Explain the relevance of the hydrological cycle to the study of hydrology	Computers, Smart board, White board, Projector, Marker, duster, Internet	- Draw the hydrological cycle - Identify the drivers of the hydrological cycle and the relevance of the hydrological cycle to the study of hydrology.	Guide student to - Draw the hydrological cycle - Identify the drivers of the hydrological cycle and the relevance of the hydrological cycle to the study of hydrology.	Laptop, Laboratory Equipment, Instruments, Writing materials, Projector
General Objective 3.0: Understand the concept of surface runoff						
4-5	3.1 Explain the meaning of surface runoff and the components of	Explain the meaning of surface runoff and the components of surface runoff or	Laptop Computers, Smart board, White board,	Identify the different components of	Guide students to: Identify the different	Laptop, Laboratory Equipment,

	surface runoff or streamflow 3.2 Explain the components of surface runoff and the methods of estimating surface runoff. 3.3 State the factors affecting runoff.	streamflow • Explain the components of surface runoff and the methods of estimating surface runoff. • Explain the factors affecting runoff.	Projector, Marker, duster, Internet	surface runoff.	components of surface runoff.	Instruments, Writing materials, Projector
General Objective 4.0: Understand Precipitation and the mechanisms that drive it						
6-7	4.1 Define precipitation and state its different forms 4.2 Explain the mode of formation of the different types of precipitation 4.3 Explain the method and instruments used in measuring precipitation 4.4 Describe the drivers of precipitation	• Explain precipitation and state its different forms • Discuss the mode of formation of the different types of precipitation • Explain the method and instruments used in measuring precipitation • Discuss the drivers of precipitation	Laptop Computers, Smart board, White board, Projector, Marker, duster, Internet	• Measure precipitation using standard rainfall measuring instruments. • Identify different types of precipitation and the atmospheric conditions responsible for their formation. • Analyse rainfall data to determine precipitation characteristics. • Carry out the influence of topography, temperature, and atmospheric	Guide students to: • Measure precipitation using standard rainfall measuring instruments. • Identify different types of precipitation and the atmospheric conditions responsible for their formation. • Analyse rainfall data to determine precipitation characteristics. • Carry out the influence of topography, temperature, and	Weather station Weather observation charts Satellite weather images Weather maps Historical rainfall data Computer with spreadsheet software Graph sheets Calculator Topographic maps Weather maps Satellite imagery Multimedia projector Laboratory/field

				conditions on precipitation. • Prepare and present a practical report on precipitation measurements and observations.	atmospheric conditions on precipitation. • Prepare and present a practical report on precipitation measurements and observations.	record sheets Computer with word processing and spreadsheet software• Meteorological manuals Rainfall data records
General Objective 5.0: Understand the unit of hydrograph						
8-9	5.1 Explain the concept, principles, and assumptions of the unit hydrograph. 5.2 Describe the methods of developing and deriving a unit hydrograph. 5.3 Explain the applications and limitations of the unit hydrograph in hydrological analysis.	• Explain the concept, principles, and assumptions of the unit hydrograph. • Discuss the methods of developing and deriving a unit hydrograph. • Explain the applications and limitations of the unit hydrograph in hydrological analysis.	Whiteboard and markers, Multimedia projector, Hydrology textbooks, Charts of hydrographs	• Separate baseflow from storm hydrographs to obtain direct runoff hydrographs. • Derive a unit hydrograph from observed rainfall and runoff data. • Apply the unit hydrograph to estimate runoff from a given storm event. • Use computer software to develop and analyse unit hydrographs. • Prepare and present a technical report on unit hydrograph analysis.	Guide students to: • Separate baseflow from storm hydrographs to obtain direct runoff hydrographs. • Derive a unit hydrograph from observed rainfall and runoff data. • Apply the unit hydrograph to estimate runoff from a given storm event. • Use computer software to develop and analyse unit hydrographs. • Prepare and present a technical report on unit hydrograph analysis.	Rainfall-runoff datasets, Graph sheets, Calculator, Computer with spreadsheet software

General Objective 6.0: Understand the measurement of stream flow						
10-11	6.1 Highlight the different methods of measuring stream flow. 6.2 Explain stage discharge rating curve and the procedures in establishing rating curves on: - Logarithmic paper - Discharge rating at stations with shifting control. 6.3 Explain the relationship between slope stage discharge.	- Explain the different methods of measuring stream flow. - Explain stage discharge rating curve and the procedures in establishing rating curves on: - Logarithmic paper - Discharge rating at stations with shifting control. - Explain the relationship between slope stage discharge.	Computers, Smart board, White board, Projector, Marker, duster, Internet	- Identify the methods of measuring stream flow. - Determine the velocity of water using current meter - Determine the methods of water storage	Guide students to: - Identify the methods of measuring stream flow. - Determine the velocity of water using current meter - Determine the methods of water storage	Current meter Acoustic Doppler Current Profiler (ADCP) Electromagnetic flow meter Float (surface float) Stopwatch Staff gauge Wading rod Measuring tape Sounding weight Current meter reel and cable River gauging station Weir (V-notch or rectangular) Parshall flume
General Objective 7.0: Understand the concept of ground water, types and ground water storage and measurement.						
12-13	7.1.Explain the concept of ground water occurrence and the concept of aquifer and types of aquifers 7.2.Explain the principles of ground water fluctuations	- Explain the concept of ground water occurrence and the concept of aquifer and types of aquifers - Explain the principles of ground water fluctuations	Computers, Smart board, White board, Projector, Marker, duster, Internet	- Measure stream velocity using appropriate flow measurement instruments. - Measure the cross-sectional area of a stream channel. - Determine stream	Guide students to: - Measure stream velocity using appropriate flow measurement instruments. - Measure the cross-sectional area of a stream channel.	Current meter, Acoustic Doppler Current Profiler (ADCP), Float, Stopwatch, Field notebook, River/stream

	and the relationships between ground water and surface water. 7.3.Explain the principle of ground water flow and differentiate between the transmissibility of confined and unconfined aquifer. 7.4.Explain the principle of well hydraulics and the principle of well construction and spacing. 7.5.Describe the purpose and approaches of groundwater exploration 7.6.Explain the hydraulic of open well	and the relationships between ground water and surface water. • Explain the principle of ground water flow and differentiate between the transmissibility of confined and unconfined aquifer. • Explain the principle of well hydraulics and the principle of well construction and spacing. • Explain the purpose and approaches of groundwater exploration • Explain the hydraulic of open well		discharge using the velocity–area method. • Develop stage–discharge (rating) curves from streamflow data. • Measure streamflow using hydraulic structures and prepare a streamflow measurement report.	• Determine stream discharge using the velocity–area method. • Develop stage–discharge (rating) curves from streamflow data. • Measure streamflow using hydraulic structures and prepare a streamflow measurement report.	
General Objective 8.0 : Understand flood estimation and control						
14-15	8.1.Discuss the meaning of flood and highlight the different types of	• Discuss the meaning of flood and highlight the different types of flood; and explain	Computers, Smart board, White board, Projector,	• Estimate flood discharge using hydrological methods and	Guide students to: • Estimate flood discharge using hydrological methods	Historical rainfall Data, Streamflow data,

	flood; and explain the causes of flood 8.2. Discuss the approaches to floods and flood hazard management 8.3. Explain soil conservation measures 8.4. Explain flood control approaches	the causes of flood • Discuss the approaches to floods and flood hazard management • Explain soil conservation measures • Explain flood control approaches	Marker, duster, Internet	historical flood data. • Delineate flood-prone areas using topographic maps and GIS tools. • Assess the performance of structural flood control measures. • Apply non-structural flood control measures in flood risk management. • Prepare presentation slides on a flood estimation and control report based on field and laboratory data.	and historical flood data. • Delineate flood-prone areas using topographic maps and GIS tools. • Assess the performance of structural flood control measures. • Apply non-structural flood control measures in flood risk management. • Prepare and present a flood estimation and control report based on field and laboratory data.	Calculator, Computer with Excel/hydrological software, Hydrology laboratory manual Flood hazard maps, Early warning system data,
--	---	---	--------------------------	--	---	---

COURSE ASSESSMENT:

Course work 10%

Test/Assignments 10%

Practical 40%

Examination 40% = 100%

PHYSICAL GEOGRAPHY AND PHOTO INTERPRETATION

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY		
COURSE TITLE: PHYSICAL GEOGRAPHY AND PHOTO INTERPRETATION	COURSE CODE: HWR 114	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: I	PRE-REQUISITE:	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills in physical geography and interpretation of photographs		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the scope, principles, concepts, and applications of watershed management in relation to drainage basins, the hydrologic cycle, and environmental systems; 2.0 Understand map scales, directions, bearings, contour lines, and the estimation of geographical dimensions for spatial analysis; 3.0 Understand the interpretation and application of human and physical maps for watershed assessment and environmental planning; 4.0 Understand the principles of aerial photograph interpretation and object identification for terrain and land-use analysis; 5.0 Understand the structure of the Earth, weathering processes, atmospheric composition, drainage systems, and their influence on watershed characteristics; 6.0 Understand the integration of watershed management, map interpretation, and environmental information for effective hydrological investigations and water resources management.		

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY						
COURSE TITLE: PLANT TAXONOMY AND IDENTIFICATION			COURSE CODE: HWR 114		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: I 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 physical geography and interpretation of photographs						
GENERAL OBJECTIVE 1.0: Understand the scope, principles, concepts, and applications of watershed management in relation to drainage basins, the hydrologic cycle, and environmental systems.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Explain the concept, scope, and objectives of watershed management. 1.2 Describe the characteristics and components of a drainage basin. 1.3 Explain the hydrologic cycle and its relationship to watershed management. 1.4 Explain the influence of environmental factors on	• Explain the concept, scope, and objectives of watershed management. • Describe the characteristics and components of a drainage basin. • Explain the hydrologic cycle and its relationship to watershed management. • Explain the influence of environmental factors on watershed management.	Hydrology textbooks, Whiteboard and markers, Multimedia projector, Watershed maps	• Delineate a watershed and identify its physical features using maps and GIS tools. • Conduct a field survey to identify drainage basin characteristics and watershed components. • Assess land use, vegetation cover, and environmental conditions within a watershed. • Prepare and present	Guide students to: • Delineate a watershed and identify its physical features using maps and GIS tools. • Conduct a field survey to identify drainage basin characteristics and watershed components. • Assess land use, vegetation cover, and environmental conditions within a watershed.	Topographic maps, GIS software (QGIS/ArcGIS), Computer, Watershed maps

	watershed management.			a watershed assessment report based on field observations and mapped data.	• Prepare and present a watershed assessment report based on field observations and mapped data.	
GENERAL OBJECTIVE 2.0: Understand map scales, directions, bearings, contour lines, and the estimation of geographical dimensions for spatial analysis.						
4-6	2.1 Explain the concepts and types of map scales and their applications. 2.2 Explain directions, bearings, and coordinate systems used in map reading. 2.3 Explain contour lines and their applications in terrain analysis. 2.4 Explain methods for estimating distances, areas, slopes, and elevations from maps.	• Explain the concepts and types of map scales and their applications. • Explain directions, bearings, and coordinate systems used in map reading. • Explain contour lines and their applications in terrain analysis. • Explain methods for estimating distances, areas, slopes, and elevations from maps.	Topographic maps Scale charts Whiteboard and markers Hydrology textbooks	• Convert map scales and measure distances and areas from topographic maps. • Determine directions and bearings using maps and a compass. • Interpret contour maps to determine terrain characteristics and watershed features. • Estimate slopes, elevations, and geographical dimensions from map data.	Guide students to: • Convert map scales and measure distances and areas from topographic maps. • Determine directions and bearings using maps and a compass. • Interpret contour maps to determine terrain characteristics and watershed features. • Estimate slopes, elevations, and geographical dimensions from map data.	Topographic maps Scale ruler Calculator Graph sheets Field notebook Contour maps Drawing instruments Computer with GIS software
GENERAL OBJECTIVE 3.0: Understand the interpretation and application of human and physical maps for watershed assessment and environmental planning.						
7-8	3.1 Explain the characteristics and uses of human and	• Explain the characteristics and uses of human and	Human and physical maps Whiteboard and	• Interpret human and physical features using	Guide students to: • Interpret human and physical features	Topographic maps Atlas Field notebook

	physical maps. 3.2 Explain map symbols, legends, and conventional signs used in map interpretation. 3.3 Explain the interpretation of human and physical features on maps. 3.4 Explain the applications of map interpretation in watershed assessment and environmental planning.	physical maps. • Explain map symbols, legends, and conventional signs used in map interpretation. • Explain the interpretation of human and physical features on maps. • Explain the applications of map interpretation in watershed assessment and environmental planning.	markers Multimedia projector Hydrology textbooks	topographic maps. • Identify and interpret map symbols, legends, and conventional signs. • Analyse land-use and environmental features using maps and GIS software. • Prepare and present a watershed map interpretation report.	using topographic maps. • Identify and interpret map symbols, legends, and conventional signs. • Analyse land-use and environmental features using maps and GIS software. • Prepare and present a watershed map interpretation report.	Magnifying lens Computer GIS software (QGIS/ArcGIS) Land-use maps Satellite imagery
GENERAL OBJECTIVE 4.0: Understand the principles of aerial photograph interpretation and object identification for terrain and land-use analysis.						
9-10	4.1 Explain the principles and concepts of aerial photograph interpretation. 4.2 Explain the elements of image interpretation used in object identification. 4.3 Explain methods of identifying terrain and land-use	• Explain the principles and concepts of aerial photograph interpretation. • Explain the elements of image interpretation used in object identification. • Explain methods of identifying terrain	Aerial photographs Whiteboard and markers Multimedia projector Remote sensing textbooks	• Interpret aerial photographs to identify natural and man-made features. • Identify objects using the elements of image interpretation. • Classify land-use and land-cover features using aerial photographs	Guide students to: • Interpret aerial photographs to identify natural and man-made features. • Identify objects using the elements of image interpretation. • Classify land-use and land-cover features using aerial photographs and GIS	Aerial photographs Magnifying lens Interpretation keys Field notebook Computer GIS software (QGIS/ArcGIS) Aerial photographs Satellite imagery

	features from aerial photographs. 4.4 Explain the applications of aerial photograph interpretation in hydrology and environmental management.	and land-use features from aerial photographs. • Explain the applications of aerial photograph interpretation in hydrology and environmental management.		and GIS software. • Prepare and present an aerial photograph interpretation report.	software. • Prepare and present an aerial photograph interpretation report.	
GENERAL OBJECTIVE 5.0: Understand the structure of the Earth, weathering processes, atmospheric composition, drainage systems, and their influence on watershed characteristics.						
11-12	5.1 Explain the structure and composition of the Earth in relation to watershed characteristics. 5.2 Explain weathering processes and their effects on watershed development. 5.3 Explain atmospheric composition and the hydrologic cycle. 5.4 Explain drainage systems and environmental factors affecting watershed	• Explain the structure and composition of the Earth in relation to watershed characteristics. • Explain weathering processes and their effects on watershed development. • Explain atmospheric composition and the hydrologic cycle. • Explain drainage systems and environmental factors affecting watershed characteristics.	Geological maps Earth structure charts Whiteboard and markers Geology and hydrology textbooks Rock and soil samples Weathering charts Multimedia projector Hydrology laboratory manual	• Identify rock types, soil profiles, and weathering features in the field. • Observe and classify drainage patterns and watershed characteristics. • Assess the effects of weathering and environmental factors on watershed conditions. • Prepare and present a field report on watershed characteristics and environmental conditions.	Guide students to: • Identify rock types, soil profiles, and weathering features in the field. • Observe and classify drainage patterns and watershed characteristics. • Assess the effects of weathering and environmental factors on watershed conditions. • Prepare and present a field report on watershed characteristics and environmental conditions.	Rock samples Soil samples Geological hammer Field notebook Topographic maps GPS receiver Compass Measuring tape

	characteristics.					
GENERAL OBJECTIVE 6.0: Understand the integration of watershed management, map interpretation, and environmental information for effective hydrological investigations and water resources management.						
13-15	6.1 Explain the integration of watershed management, map interpretation, and environmental information in hydrological investigations. 6.2 Explain the application of maps and environmental data in water resources planning and management. 6.3 Explain the importance of watershed conservation and sustainable environmental management. 6.4 Explain the role of hydrological investigations in environmental monitoring and decision-making.	• Explain the integration of watershed management, map interpretation, and environmental information in hydrological investigations. • Explain the application of maps and environmental data in water resources planning and management. • Explain the importance of watershed conservation and sustainable environmental management. • Explain the role of hydrological investigations in environmental monitoring and decision-making.	Hydrology textbooks Watershed maps Multimedia projector Whiteboard and markers	• Conduct an integrated watershed assessment using maps, field observations, and environmental data. • Analyse spatial and environmental data for watershed management. • Develop a simple watershed management plan based on field and spatial data. • Prepare and present a technical report on watershed investigation and management.	Guide students to: • Conduct an integrated watershed assessment using maps, field observations, and environmental data. • Analyse spatial and environmental data for watershed management. • Develop a simple watershed management plan based on field and spatial data. • Prepare and present a technical report on watershed investigation and management.	Topographic maps GPS receiver Field notebook GIS software (QGIS/ArcGIS) Computer GIS software Environmental datasets Satellite imagery Watershed maps Planning templates Hydrology laboratory manual Computer

COURSE ASSESSMENT:

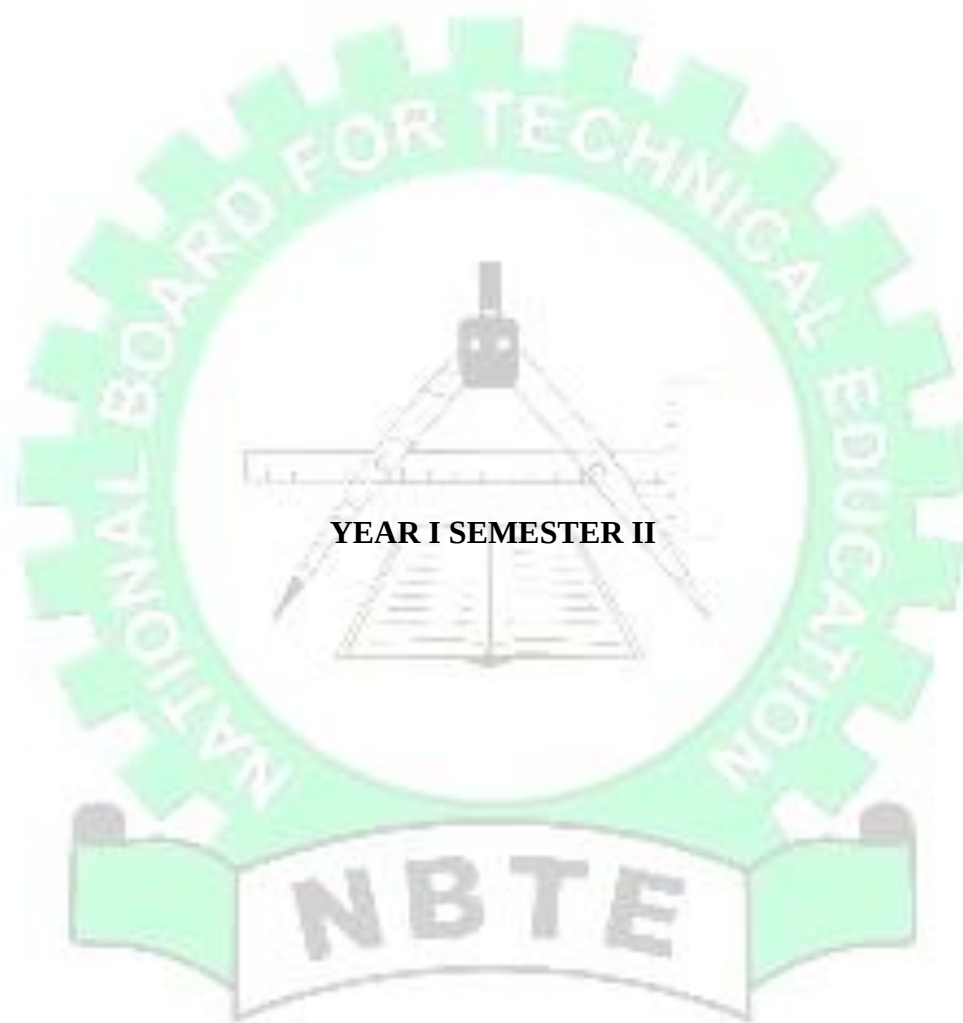
Course work 10%

Test/Assignments 10%

Practical 40%

Examination 40% = 100%





YEAR I SEMESTER II

HYDROLOGY AND HYDRO-STATISTICS

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY		
COURSE TITLE: HYDROLOGY AND HYDRO-STATISTICS	COURSE CODE: HWR 121	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: II	PRE-REQUISITE:	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills of hydrology and hydro-statistics		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand hydrology cycle and water balance; 2.0 Understand hydrological catchment and geomorphologic characteristics; 3.0 Understand hydrological process and interactions; 4.0 Understand hydrological regimes; 5.0 Understand ecohydrology; 6.0 Understanding the nature of hydrostatistical data, their types and uses; 7.0 Understand the procedures for collecting and summarizing hydrostatistical data; 8.0 Understand the methods of hydro-data compilation and presentation; 9.0 Understand the probability theory and their application in hydrology; 10.0 Know the methods of estimating missing data in hydrological and water resources; 11.0 Know the methods of estimation of variability of hydrological data; 12.0 Understand the methods of predicting hydrological hazards.		

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY						
COURSE TITLE: HYDROLOGY AND HYDRO-STATISTICS			COURSE CODE: HWR 121		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: II			PRE-REQUISITE:		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills of hydrology and hydro-statistics						
General Objectives 1.0: Understand hydrology cycle and water balance						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1	1.1 Explain hydrological cycle. 1.2 Explain water balance 1.3 Explain water budget 1.4 Explain negative water balance 1.5 List importance of water balance	• Explain hydrological cycle. • Explain water balance • Explain water budget • Explain negative water balance • List importance of water balance	Charts, Diagrams, White board, marker and Overhead projector	• Identify the components of the hydrologic cycle during field investigations. • Measure selected hydrological parameters related to the water balance. • Analyse the water balance of a watershed using field data. • Present a hydrologic cycle and water balance report.	Guide students to: • Observe and identify the components of the hydrologic cycle during field investigations. • Measure selected hydrological parameters related to the water balance. • Calculate and analyse the water balance of a watershed using field data. • Prepare and present a hydrologic cycle and water balance report.	Field notebook Watershed/river basin GPS receiver Personal Protective Equipment (PPE) Weather station

General Objectives 2.0: Understand hydrological catchment and geomorphological characteristics						
2	2.1 Explain the concept, characteristics, and classification of hydrological catchments. 2.2 Explain the geomorphological characteristics of river basins and watersheds. 2.3 Explain the influence of geological, soil, and land-use characteristics on hydrological catchments. 2.4 Explain the applications of catchment and geomorphological characteristics in water resources management.	• Explain the concept, characteristics, and classification of hydrological catchments. • Explain the geomorphological characteristics of river basins and watersheds. • Explain the influence of geological, soil, and land-use characteristics on hydrological catchments. • Explain the applications of catchment and geomorphological characteristics in water resources management.	Charts, Diagrams, White board, marker and Overhead projector	• Delineate a hydrological catchment using topographic maps and GIS software. • Identify geomorphological features within a catchment. • Analyse the effects of geology, soils, land use, and drainage characteristics on catchment behaviour. • Present a hydrological catchment assessment report.	Guide students to: • Delineate a hydrological catchment using topographic maps and GIS software. • Identify and classify geomorphological features within a catchment. • Analyse the effects of geology, soils, land use, and drainage characteristics on catchment behaviour. • Prepare and present a hydrological catchment assessment report.	Topographic maps GIS software (QGIS/ArcGIS) Computer Watershed maps GPS receiver Topographic maps Field notebook Personal Protective Equipment (PPE)
General Objectives 3.0: Understand hydrological process and interactions						
3-4	3.1 Explain the followings aspects of hydrological processes	• Explain the followings aspects of hydrological processes	White board, marker, Overhead projector, Rain	• Demonstrate methods of measuring of precipitation	Guide students to: • Demonstrate methods of measuring of	Rainfall data Runoff data Infiltration data Soil data

	Precipitation Evapotranspiration 3.2 Explain Surface run-off formation 3.3 Explain infiltration 3.4 Explain soil moisture 3.5 Explain Groundwater flow 3.6 Explain the interactions between hydrological processes.	Precipitation Evapotranspiration • Explain Surface run-off formation • Explain infiltration • Explain soil moisture • Explain Groundwater flow • Explain the interactions between hydrological processes.	gauge, Hygrometer Lysimeter Field trip to stream or river Tensiometer	• Demonstrate method of measuring of evaporation using psychrometer • Demonstrate methods of measuring of surface run-off using flow gauge, tracer technique • Demonstrate methods of measuring of surface run-off using flow gauge, tracer technique • Identify equipment and demonstrate method of measuring of infiltration • Demonstrate method of measuring of soil moisture • Demonstrate the use terameter for finding groundwater	precipitation • Demonstrate method of measuring of evaporation using psychrometer • Demonstrate methods of measuring of surface run-off using flow gauge, tracer technique • Demonstrate methods of measuring of surface run-off using flow gauge, tracer technique • Identify equipment and demonstrate method of measuring of infiltration • Demonstrate method of measuring of soil moisture • Demonstrate the use terameter for finding groundwater	Relative humidity Groundwater data etc.
General Objectives 4.0: Understand hydrological regimes.						

5-6	4.1 Explain hydrological regimes 4.2 Describe flow regime classification, ephemeral, intermittent, perennial. 4.3 Enumerate stream flow characteristics, e.g. magnitude, frequency, duration, timing and rate of changes of flow etc 4.4 Explain the effect of seasonal changes on flow regimes	• Explain hydrological regimes • Discuss flow regime classification, ephemeral, intermittent, perennial. • Explain stream flow characteristics, e.g. magnitude, frequency, duration, timing and rate of changes of flow etc • Explain the effect of seasonal changes on flow regimes	White board, marker, Overhead projector Field Trip	• Identify hydrological regimes of streams types • Identify various stream types and their characteristics	Guide students to: • Identify hydrological regimes of streams types • Identify various stream types and their characteristics	Stream flow data
General Objectives 5.0: Understand ecohydrology.						
7-8	5.1 Define ecohydrology 5.2 Describe the importance of forest on hydrological regimes, flood and erosion control etc. 5.3 Explain the effect of hydrological regimes on migratory fishes	• Explain ecohydrology • Discuss the importance of forest on hydrological regimes, flood and erosion control etc. • Explain the effect of hydrological regimes on migratory fishes especially as it	White board, marker, Overhead projector	• Assess the interaction between water resources and ecosystems during field investigations. • Evaluate the effects of vegetation, soils, and land use on ecohydrological processes. • Analyse ecohydrological data using field	• Assess the interaction between water resources and ecosystems during field investigations. • Evaluate the effects of vegetation, soils, and land use on ecohydrological processes. • Analyse ecohydrological data using field	Soil sampling tools Vegetation identification guide Land-use maps Digital camera Computer GIS software (QGIS/ArcGIS) Satellite imagery Environmental datasets

	especially as it affects reproduction, timing of migration and availability of flood	affects reproduction, timing of migration and availability of flood		observations and GIS tools. • Prepare and present an ecohydrological assessment report for a selected watershed.	observations and GIS tools. • Prepare and present an ecohydrological assessment report for a selected watershed.	
General Objective 6.0: Understanding the nature of hydrostatistical data, their types and uses.						
9	6.1 Define statistics 6.2 Explain the various sources of statistical data. 6.3 State the uses of statistical data and 6.4 Explain the types of measurement scales 6.5 Describe the measures of central tendencies-mean, mode and median (both grouped and ungrouped) 6.6 Describe the measures of dispersion-standard deviations, variance, coefficients of variation etc including their merits and demerits.	• Explain statistics • Explain the various sources of statistical data. • Discuss the uses of statistical data and • Explain the types of measurement scales • Explain the measures of central tendencies-mean, mode and median (both grouped and ungrouped) • Discuss the measures of dispersion-standard deviations, variance, coefficients of variation etc including their merits and demerits.	White board, marker, Overhead projector			

General Objective 7.0: Understand the procedures for collecting and summarizing hydrostatistical data						
10	7.1. Describe the methods of hydrodata collection (Census, sample survey, experiment, observational study,) 7.2. Explain the steps in planning and conducting surveys and state the characteristics of well-designed and well conducted surveys. 7.3. Explain the meaning of sampling and describe relevant sampling terminologies- population, sampling frame, target population etc. 7.4. Describe the different types of sampling methods (probability and non-probability)	• Explain the methods of hydrodata collection (Census, sample survey, experiment, observational study,) • Explain the steps in planning and conducting surveys and state the characteristics of well-designed and well conducted surveys. • Discuss the meaning of sampling and describe relevant sampling terminologies- population, sampling frame, target population etc. • Discuss the different types of sampling methods (probability and non-probability) with examples and the sources of bias in sampling and surveys	White board, marker, Overhead projector			

	with examples and the sources of bias in sampling and surveys					
General Objectives 8.0: Understand the methods of hydrological data compilation, summarisation and presentation						
11	8.1 Describe the methods of hydro- statistical methods compilation and presentation (charts, pictorial, tables, graphs, diagrams) 8.2 Describe the methods of presenting hydro- data using any of the aforementioned stating their merits and demerits. 8.3 Outline the methods of constructing and interpreting graphical displays of distributions of univariate data (dot plot, histogram,	• Discuss the methods of hydro- statistical methods compilation and presentation (charts, pictorial, tables, graphs, diagrams) • Explain the methods of presenting hydro- data using any of the aforementioned stating their merits and demerits. • Discuss the methods of constructing and interpreting graphical displays of distributions of univariate data (dot plot, histogram,	White board, marker, Overhead projector			

	cumulative frequencies plot etc.)	cumulative frequencies plot etc.)				
General Objectives 9.0: Understand the Probability theory and their applications in hydrology						
12	9.1. Define probability and describe the methods of interpreting probability including long run relative frequency interpretation and the law of large numbers. 9.2. Explain the addition rule, multiplication rule, conditional probability and independence 9.3. Differentiate between discrete, binomial, poisson and normal distributions and explain their applications to hydrological studies or systems	• Discuss probability and describe the methods of interpreting probability including long run relative frequency interpretation and the law of large numbers. • Explain the addition rule, multiplication rule, conditional probability and independence • Distinguished between discrete, binomial, poisson and normal distributions and explain their applications to hydrological studies or systems	White board, marker, Overhead projector			

General Objective 10.0: Know the methods of estimating Missing Data in Hydrology and Water Resources						
13	10.1. Explain the meaning and sources of missing data in hydrology and water resources studies. 10.2. Describe the statistical methods of estimating missing data in hydrology and water resources 10.3. Explain inferential statistics and tests of significance in hydrodata	• Explain the meaning and sources of missing data in hydrology and water resources studies. • Describe the statistical methods of estimating missing data in hydrology and water resources (Least Square method, Cumulative Deviations method, Likelihood ratio test, Run test, Inverse distance method Arithmetic mean method etc). • Discuss inferential statistics and tests of significance in hydrodata using Chi-square test for goodness of fit, Spearman's ranked correlation, t-distributions, analysis of	White board, marker, Overhead projector			

		variance and simple regression analysis				
General Objective 11.0: Know the methods of estimating Variability of Hydrologic Data						
14	11.1 Explain variability 11.2 Define the various measures of variability (range, quartile deviation, percentile range, mean deviation, variance and standard deviation). 11.3 Compute and interpret results using any hydrometeorological data for ungrouped and grouped data. 11.4 State the properties of variance. 11.5 Compute the variance and standard deviations in hydrology data.	• Explain variability • Discuss the various measures of variability (range, quartile deviation, percentile range, mean deviation, variance and standard deviation). • Compute and interpret results using any hydrometeorological data for ungrouped and grouped data. • State the properties of variance. • Compute the variance and standard deviations in hydrology data.	White board, marker, Overhead projector			
General Objective 12.0: Understand the Methods of Predicting Hydrological Hazards						

15	12.1 Define hydrological hazards. 12.2 Mention examples of hydrological hazards. 12.3 Describe hydrological hazard using appropriate statistical procedure (Poisson distribution, Monte Carlo analysis)	• Discuss hydrological hazards. • Outline examples of hydrological hazards. • Explain hydrological hazard using appropriate statistical procedure (Poisson distribution, Monte Carlo analysis)	White board, marker, Overhead projector			
COURSE ASSESSMENT: Course work 10% Test/Assignments 10% Practical 40% Examination 40% = 100%						

BASIC HYDRAULICS

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY		
COURSE TITLE: BASIC HYDRAULICS	COURSE CODE: HWR 122	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: II	PRE-REQUISITE:	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills of principles governing the behaviour of water at rest and in motion.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the fundamental principles of hydrostatics and fluid pressure in hydraulic systems; 2.0 Understand the principles and characteristics of fluid flow in open channels and pipes and the calculation of hydraulic parameters; 3.0 Understand the application of hydraulic principles, including Bernoulli's equation, Chezy's equation, and Manning's equation in the analysis and design of hydraulic systems; 4.0 Understand the principles, operation, and applications of hydraulic flow-measuring devices, including flumes, notches, weirs, and orifices for flow measurement; 5.0 Understand the effects of backwater and bifurcation on hydraulic flow and apply hydraulic principles to analyse and solve practical fluid flow problems.		

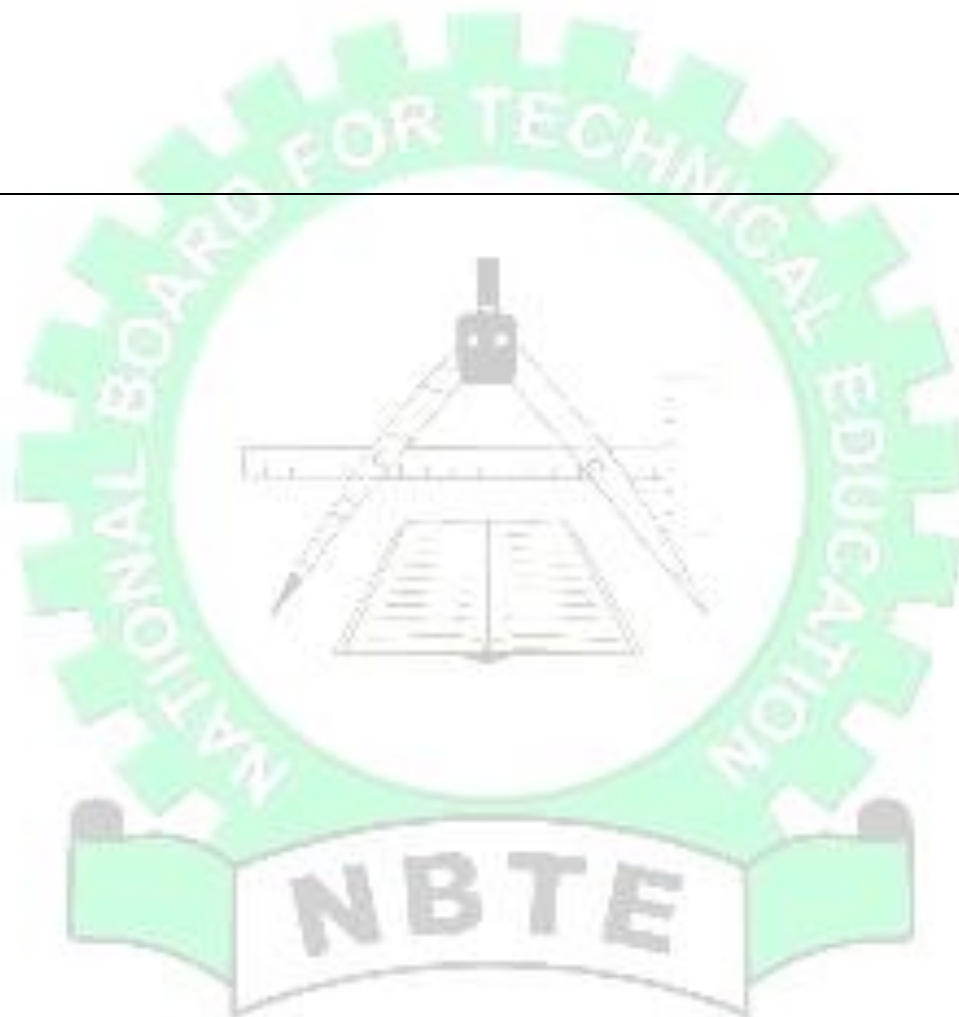
PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY						
COURSE TITLE: BASIC HYDRAULICS			COURSE CODE: HWR 122		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: II			PRE-REQUISITE:		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills of principles governing the behaviour of water at rest and in motion.						
GENERAL OBJECTIVE 1.0: Understand the fundamental principles of hydrostatics and fluid pressure in hydraulic systems.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Explain the concepts of force, area, pressure, and their SI units. 1.2 Explain the principles of hydrostatics and fluid pressure. 1.3 Explain hydrostatic pressure on submerged surfaces. 1.4 Explain the applications of hydrostatic principles in hydraulic engineering.	• Explain the concepts of force, area, pressure, and their SI units. • Explain the principles of hydrostatics and fluid pressure. • Explain hydrostatic pressure on submerged surfaces. • Explain the applications of hydrostatic principles in hydraulic engineering.	White board, marker, Overhead projector	• Measure force, area, and pressure using appropriate instruments. • Verify Pascal's law through laboratory experiments. • Determine hydrostatic pressure acting on submerged surfaces. • Present a hydrostatics laboratory report.	Guide students to: • Measure force, area, and pressure using appropriate instruments. • Verify Pascal's law through laboratory experiments. • Determine hydrostatic pressure acting on submerged surfaces. • Prepare and present a hydrostatics laboratory report.	Spring balance Pressure gauge Measuring tape PPE Pascal's apparatus Hydraulic press model Water tank Laboratory manual Hydrostatic pressure apparatus Measuring scale Calculator Data sheets

GENERAL OBJECTIVE 2.0: Understand the principles and characteristics of fluid flow in open channels and pipes and the calculation of hydraulic parameters.						
4-6	2.1 Explain the principles of fluid flow in open channels and pipes. 2.2 Explain the characteristics of laminar and turbulent flow, and steady and unsteady flow. 2.3 Explain the characteristics of uniform and non-uniform flow in open channels. 2.4 Explain the calculation of hydraulic parameters for open channel and pipe flow.	• Explain the principles of fluid flow in open channels and pipes. • Explain the characteristics of laminar and turbulent flow, and steady and unsteady flow. • Explain the characteristics of uniform and non-uniform flow in open channels. • Explain the calculation of hydraulic parameters for open channel and pipe flow.	White board, marker, Overhead projector	• Demonstrate fluid flow in open channels and pipes using laboratory models. • Determine laminar and turbulent flow using Reynolds experiment. • Calculate hydraulic parameters from field or laboratory measurements. • Present a report on open channel and pipe flow experiments.	Guide students to • Demonstrate fluid flow in open channels and pipes using laboratory models. • Determine laminar and turbulent flow using Reynolds experiment. • Calculate hydraulic parameters from field or laboratory measurements. • Prepare and present a report on open channel and pipe flow experiments.	Hydraulic flume Pipe flow apparatus Water supply system PPE Reynolds apparatus Dye injector Stopwatch Measuring cylinder Current meter Measuring tape Calculator Data recording sheets
GENERAL OBJECTIVE 3.0: Understand the application of hydraulic principles, including Bernoulli's equation, Chezy's equation, and Manning's equation in the analysis and design of hydraulic systems.						
7-9	3.1 Explain the principles, assumptions, and applications of Bernoulli's equation.	• Explain the principles, assumptions, and applications of Bernoulli's equation. • Explain the	White board, marker, Overhead projector	• Apply Bernoulli's equation to determine flow characteristics in laboratory experiments.	Guide students to: • Apply Bernoulli's equation to determine flow characteristics in laboratory	Bernoulli's apparatus Pressure gauges Measuring scale Laboratory manual

	3.2 Explain the principles and applications of Chezy's equation for open channel flow. 3.3 Explain the principles and applications of Manning's equation. 3.4 Explain the application of Bernoulli's, Chezy's, and Manning's equations in hydraulic analysis and design.	principles and applications of Chezy's equation for open channel flow. • Explain the principles and applications of Manning's equation. • Explain the application of Bernoulli's, Chezy's, and Manning's equations in hydraulic analysis and design.		• Apply Chezy's equation to determine flow velocity and discharge in open channels. • Apply Manning's equation to calculate hydraulic parameters for open channels. • Present a hydraulic analysis report using Bernoulli's, Chezy's, and Manning's equations.	experiments. • Apply Chezy's equation to determine flow velocity and discharge in open channels. • Apply Manning's equation to calculate hydraulic parameters for open channels. • Prepare and present a hydraulic analysis report using Bernoulli's, Chezy's, and Manning's equations.	Hydraulic flume Measuring tape Current meter Calculator Manning's coefficient tables Calculator Data recording sheets
GENERAL OBJECTIVE 4.0: Understand the principles, operation, and applications of hydraulic flow-measuring devices, including flumes, notches, weirs, and orifices for flow measurement.						
10-12	4.1 Explain the principles and classification of hydraulic flow-measuring devices. 4.2 Explain the construction, operation, and working principles of flumes, notches, weirs, and orifices. 4.3 Explain the factors	• Explain the principles and classification of hydraulic flow-measuring devices. • Explain the construction, operation, and working principles of flumes, notches, weirs, and orifices. • Explain the factors	White board, marker, Overhead projector	• Install flumes, notches, weirs, and orifices for flow and operate them. • Measure discharge using hydraulic flow-measuring devices. • Calibrate flow measuring devices. • Evaluate the	Guide students to: • Install and operate flumes, notches, weirs, and orifices for flow measurement. • Measure discharge using hydraulic flow-measuring devices. • Calibrate and evaluate the performance of flow-measuring devices.	Hydraulic flume V-notch and rectangular notch Weir models Orifice apparatus Stopwatch Measuring tank Staff gauge Measuring cylinder Calibration

	affecting the accuracy and efficiency of hydraulic flow measurements. 4.4 Explain the applications of hydraulic flow-measuring devices in water resources engineering.	affecting the accuracy and efficiency of hydraulic flow measurements. • Explain the applications of hydraulic flow-measuring devices in water resources engineering.		performance of flow-measuring devices. • Present a technical report on hydraulic flow measurements.	• Prepare and present a technical report on hydraulic flow measurements.	equipment Calculator Data recording sheets Computer
GENERAL OBJECTIVE 5.0: Understand the effects of backwater and bifurcation on hydraulic flow and apply hydraulic principles to analyse and solve practical fluid flow problems.						
13-15	5.1 Explain the concepts, causes, and effects of backwater in hydraulic systems. 5.2 Explain the concept and characteristics of bifurcation in rivers and channels. 5.3 Explain the effects of backwater and bifurcation on hydraulic structures and water resources management. 5.4 Explain the application of hydraulic principles in solving practical	• Explain the concepts, causes, and effects of backwater in hydraulic systems. • Explain the concept and characteristics of bifurcation in rivers and channels. • Explain the effects of backwater and bifurcation on hydraulic structures and water resources management. • Explain the application of hydraulic principles in solving practical	White board, marker, Overhead projector	• Demonstrate backwater effects using hydraulic laboratory models. • Investigate flow bifurcation using laboratory or field models. • Analyse hydraulic data to evaluate the effects of backwater and bifurcation. • Prepare and present a technical report on backwater and bifurcation investigations.	Guide students to: • Demonstrate backwater effects using hydraulic laboratory models. • Investigate flow bifurcation using laboratory or field models. • Analyse hydraulic data to evaluate the effects of backwater and bifurcation. • Prepare and present a technical report on backwater and bifurcation investigations.	Hydraulic flume Adjustable gate Staff gauge (PPE) Channel model Flow meter/current meter Measuring tape Stopwatch Computer with Microsoft Excel Calculator Hydraulic data sheets Graph paper

	fluid flow problems.	fluid flow problems.				
COURSE ASSESSMENT: Course work 10% Test/Assignments 10% Practical 40% Examination 40% = 100%						



GIS AND REMOTE SENSING

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY		
COURSE TITLE: GIS AND REMOTE SENSING	COURSE CODE: HWR 123	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: II	PRE-REQUISITE:	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills in collecting, analyzing, and visualizing spatial data for informed decision-making in environmental management, planning and resource monitoring with climate change assessment		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the basic principles of GIS and Remote Sensing; 2.0 Understand Geographic Information Concepts and Spatial Models; 3.0 Understand practical issues associated with managing data capture project; 4.0 Understand Data acquisition and processing; 5.0 Understand Spatial Databases; 6.0 Understand Spatial Data Infrastructures; 7.0 Know Remote Sensing techniques in the study of climate changes.		

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY						
COURSE TITLE: GIS AND REMOTE SENSING			COURSE CODE: HWR 123		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: II			PRE-REQUISITE:		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills in collecting, analyzing, and visualizing spatial data for informed decision-making in environmental management, planning and resource monitoring with climate change assessment						
General Objective Understand the Basic Principles of GIS and Remote Sensing						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Define GIS and Remote Sensing. 1.2 Explain components of GIS. 1.3 Describe principles of Remote Sensing. 1.4 Differentiate GIS from Remote Sensing. 1.5 Explain applications of GIS and Remote Sensing in water resources management	• Explain GIS and Remote Sensing. • Describe principles of Remote Sensing. • Differentiate GIS from Remote Sensing. • Explain applications of GIS and Remote Sensing in water resources management	Whiteboard, GIS textbooks, Projector. Charts GIS software. Diagrams, Satellite imagery. Case studies, video clips. Journals, Maps	• Identify GIS hardware and software. • Identify remote sensing platforms and sensors. • Navigate GIS software interface. • Display and visualize spatial data	Guide students to: • Identify GIS hardware and software. • Identify remote sensing platforms and sensors. • Navigate GIS software interface. • Display and visualize spatial data. • Identify GIS hardware and software. • Record and report findings	Computers QGIS/ArcGIS. Satellite imagery. GIS software, Projector

General Objective 2.0: Understand Geographic Information Concepts and Spatial Models						
4-5	2.1 Define geographic information and spatial data. 2.2 Explain spatial data models. 2.3 Describe coordinate systems and map projections. 2.4 Explain spatial relationships and topology. 2.5 Describe spatial analysis models.	• Discuss geographic information and spatial data. • Explain spatial data models. • Describe coordinate systems and map projections. • Explain spatial relationships and topology. • Describe spatial analysis models	Computer Charts. GIS manuals. Maps, projection charts. Diagrams Projector. GIS software manuals	• Create vector and raster datasets. • Perform georeferencing of maps. • Conduct simple spatial analysis. • Interpret spatial relationships. • Record and report findings	Guide students to: • Create vector and raster datasets. • Perform georeferencing of maps. • Conduct simple spatial analysis. • Interpret spatial relationships. • Record and report findings	Computer GIS software. Scanned maps GIS. Projector. Digital maps. Topographical maps.
General Objective 3.0: Understand Practical Issues Associated with Managing Data Capture Projects						
6-7	3.1 Define data capture projects. 3.2 Explain stages of data capture. 3.3 Identify sources of errors in data capture. 3.4 Describe quality assurance and quality control procedures. 3.5 Describe project management principles in GIS projects	• Discuss data capture projects- • Explain stages of data capture. • Identify sources of errors in data capture. • Discuss quality assurance and quality control procedures. • Explain project management principles in GIS projects	Computer Projector Project manuals. Flow charts. Case studies. QA/QC manuals. Project management guides	• Develop data capture plans. • Conduct field data collection. • Validate captured data. • Prepare project reports. • Record and report findings	Guide students to: • Develop data capture plans. • Conduct field data collection. • Validate captured data. • Prepare project reports. • Record and report findings	Computer, GPS receivers, GIS software, Report templates, Topographical maps.

General Objective 4.0: Understand Data Acquisition and Processing						
8-9	4.1 Define spatial data acquisition. 4.2 Identify data acquisition techniques. 4.3 Explain image processing concepts. 4.4 Describe data preprocessing procedures. 4.5 Explain data integration methods	• Discuss spatial data acquisition. • Identify data acquisition techniques. • Explain image processing concepts. • Explain data preprocessing procedures, • Explain data integration methods	Textbooks. GIS manuals. Satellite imagery. Image processing software. Case studies. Database manuals	• Demonstrate GPS field operations. • Digitize maps and features. • Demonstrate image enhancement techniques. • Perform image classification. • Record and report finding	Guide students to: • Demonstrate GPS field operations. • Digitize maps and features. • Demonstrate image enhancement techniques. • Perform image classification. • Record and report finding	GPS units. GIS software. Remote sensing software. Satellite imagery. Computer Projector
General Objective 5.0: Understand Spatial Databases						
10-11	5.1 Define spatial databases. 5.2 Describe database structures. 5.3 Explain spatial database management systems. 5.4 Discuss data storage and retrieval methods. 5.5 Explain database security and maintenance	• Explain spatial databases. • Describe database structures. • Explain spatial database management systems. • Discuss data storage and retrieval methods. • Explain database security and maintenance	GIS software Charts. Computer. Database administration guides. Computer	• Demonstrate database creation procedures. • Carry out data entry exercises. • Perform database queries. • Update databases. • Maintain databases. • Report findings	Guide students to: • Demonstrate database creation procedures. • Carry out data entry exercises. • Perform database queries. • Update and maintain databases. • Record and report findings	GIS software. Computers. Database systems. GIS software
General Objective 6.0: Understand Spatial Data Infrastructures (SDI)						

12-13	6.1 Define Spatial Data Infrastructure. 6.2 Describe components of SDI. 6.3 Explain metadata standards 6.4 Describe data sharing and interoperability. 6.5 Explain national and global SDI initiatives	• Discuss Spatial Data Infrastructure. • Explain components of SDI. • Explain metadata standards. • Explain data sharing and interoperability. • Explain national and global SDI initiatives	Charts. Metadata guidelines. Case studies. Internet resources	• Demonstrate metadata documentation. • Carry out data retrieval exercises. • Demonstrate data exchange procedures. • Evaluate SDI applications. • Record findings • Report findings	Guide students to : • Demonstrate metadata documentation. • Carry out data retrieval exercises. • Demonstrate data exchange procedures. • Evaluate SDI applications • Record findings • Report findings	Internet access. Computer. SDI portals. Metadata guidelines
General Objective 7.0: Know Remote Sensing Techniques in the Study of Climate Change						
14-15	7.1. Define climate change and remote sensing. 7.2. Describe remote sensing indicators of climate change. 7.3. Explain satellite monitoring systems. 7.4. Describe climate change impacts on water resources. 7.5. Explain methods of climate change assessment	• Explain climate change and remote sensing. • Explain remote sensing indicators of climate change. • Explain satellite monitoring systems. • Discuss climate change impacts on water resources. • Explain methods of climate change assessment	Climate reports. Satellite imagery. Multimedia presentations. Case studies	• Demonstrate image interpretation techniques for land use change. • Perform change detection analysis. • Generate thematic maps showing climate impacts. • Prepare climate change assessment reports. • Report findings	Guide students to: • Demonstrate image interpretation techniques for land use change. • Perform change detection analysis. • Generate thematic maps showing climate impacts. • Prepare climate change assessment reports. • Record and report findings	Satellite imagery. GIS and Remote Sensing software, Computer system, Report templates.
COURSE ASSESSMENT: Course work: 10%						

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



INTRODUCTION TO HYDROMETEOROLOGY

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY		
COURSE TITLE: INTRODUCTION TO HYDROMETEOROLOGY	COURSE CODE: HWR 124	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: II	PRE-REQUISITE:	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills in hydrometeorological processes and apply data analysis, forecasting, modelling, and geospatial technologies for sustainable water resources management and disaster risk reduction.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the relationships between meteorology and hydrology; 2.0 Understand the water cycle; 3.0 Understand the meteorological elements; 4.0 Understand the measurement of precipitation; 5.0 Understand the meteorological and hydrological forecasting.		

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY						
COURSE TITLE: INTRODUCTION TO HYDROMETEOROLOGY			COURSE CODE: HWR 124		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: II			PRE-REQUISITE:		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills in hydrometeorological processes and apply data analysis, forecasting, modelling, and geospatial technologies for sustainable water resources management and disaster risk reduction.						
General objective 1.0: understand the relationship between meteorology and hydrology						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Explain the relationship between meteorology and hydrology 1.2 Describe the general principles of forecasting 1.3 Explain meteorological forecasting 1.4 Explain hydrological forecasting	• Discuss the relationship between meteorology and hydrology • Explain the general principles of forecasting • Explain meteorological forecasting • Explain hydrological forecasting	Textbooks and reference material, Charts, Multimedia resources, Scientific Journals and articles, Maps and Atlases, ICT and digital tools.	• Conduct experiments on evaporation in a bowl of water and condensation on a cold surface. • Visit weather stations or river basins. • Demonstrate how rainfall data is collected and how river discharge is measured. • Record daily weather observations and	Guide students to: • Conduct experiments on evaporation in a bowl of water and condensation on a cold surface. • Visit weather stations or river basins. • Demonstrate how rainfall data is collected and how river discharge is measured. • Record daily weather observations and link them to local water	Flow meter Water sampling bottles Soil moisture meter Evaporation pan Protective gear (boots, raincoats, gloves) GPS devices Cameras Portable weather stations Measuring tapes and rods for river cross-

				link them to local water		sections
General objective 2.0: understand the water cycle						
4-6	2.1 Define the core concept of water cycle 2.2 Describe the main processes of water cycle 2.3 Explain the relationship between meteorological factors (temperature, humidity, wind) and hydrological processes (runoff, river flow, groundwater storage)	- Define the core concept of water cycle - Describe the main processes of water cycle - Explain the relationship between meteorological factors (temperature, humidity, wind) and hydrological processes (runoff, river flow, groundwater storage)	Textbooks and reference material, Charts, Multimedia resources, Scientific Journals and articles, Maps and Atlases, ICT and digital tools.	- Know how to set up and use meteorological tools (rain gauge, thermometer, hygrometer, anemometer). - Operate hydrological instruments to measure water levels and stream velocity. - Record daily rainfall, temperature, humidity, and wind speed. - Record river discharge, soil moisture, and evaporation rates during fieldwork. - Plot rainfall data against river discharge to identify correlations. - Calculate	Guide students to: - Know how to set up and use meteorological tools (rain gauge, thermometer, hygrometer, anemometer). - Operate hydrological instruments to measure water levels and stream velocity. - Record daily rainfall, temperature, humidity, and wind speed. - Record river discharge, soil moisture, and evaporation rates during fieldwork. - Plot rainfall data against river discharge to identify correlations. - Calculate evaporation rates and compare them with	Staff gauge or stream gauge (river water level) Flow meter (stream velocity) Water sampling bottles (quality testing) moisture meter Evaporation pan (measuring evaporation rates)

				evaporation rates and compare them with temperature variations. • Interpret soil moisture readings to assess drought conditions	temperature variations. • Interpret soil moisture readings to assess drought conditions	
General objective 3.0: understand the meteorological elements						
7-9	3.1 Define the followings Core Meteorological Elements - Temperature - Humidity - Precipitation - Wind - Atmospheric pressure - Sunshine and radiation 3.2 Discuss key weather variables and explain their significance. 3.3 Explain meteorological data to make predictions. 3.4 Explain the impact of weather on agriculture, health, and infrastructure.	• Define the followings Core Meteorological Elements – Temperature – Humidity – Precipitation – Wind – Atmospheric pressure – Sunshine and radiation • Discuss key weather variables and explain their significance. • Explain meteorological data to make predictions. • Discuss the impact of weather on agriculture, health, and infrastructure.	Textbooks and reference material, Charts, Multimedia resources, Scientific Journals and articles, Maps and Atlases, ICT and digital tools.	• Record weather data using simple instruments and keep a weather diary. • Analyze weather patterns by interpreting charts, graphs, and satellite images. • Forecast short-term weather based on collected data and observations.	• Guide students to: Record weather data using simple instruments and keep a weather diary. • Analyze weather patterns by interpreting charts, graphs, and satellite images. • Forecast short-term weather based on collected data and observations.	Plastic bottles and jars Cardboard and paper Colored markers: Maps and atlases: Local meteorological agency reports School garden

General Objective 4.0. Understand the measurement of precipitation						
10-12	4.1 Explain the types and mechanisms of formation 4.2 Describe the mechanisms of formation of precipitation's stated above 4.3 Distinguish between various forms of precipitation 4.4 Describe the basic instruments for the measurement of precipitation. 4.5 Explain the need to establish a network of gauge stations in an area.	• Explain the types and mechanisms of formation • Explain the mechanisms of formation of precipitation's stated above • Distinguish between various forms of precipitation • Discuss the basic instruments for the measurement of precipitation. • Explain the need to establish a network of gauge stations in an area.	Textbooks and reference material, Charts, Multimedia resources, Scientific Journals and articles, Maps and Atlases, ICT and digital tools.	• Measure precipitation using standard rain gauges. • Operate automatic precipitation measuring instruments. • Record, analyze, and interpret precipitation data. • Maintain precipitation measuring instruments. • Conduct a field exercise on precipitation measurement.	Guide students to: • Measure precipitation using standard rain gauges. • Operate automatic precipitation measuring instruments. • Record, analyze, and interpret precipitation data. • Maintain precipitation measuring instruments. • Conduct a field exercise on precipitation measurement.	Meteorological station. Individual measuring equipment and gauges
General Objective 5.0: Understand the meteorological and hydrological forecasting						
13-15	5.1 Define meteorological forecasting and hydrological forecasting 5.2 Explain the scientific principles underlying weather prediction and	• Explain meteorological forecasting and hydrological forecasting • Explain the scientific principles underlying weather prediction and	Computers, smart board, projector, writing materials, whiteboard, markers, internet	• Collect meteorological and hydrological data using appropriate instruments. • Interpret weather charts, satellite images, and hydrographs.	Guide students to: • Collect meteorological and hydrological data using appropriate instruments. • Interpret weather charts, satellite images, and	Data from National Meteorological Agency datasets NiMet). Hydrological data from river basin authorities and water

	hydrological forecasting 5.3 Describe forecasting models (numerical weather prediction, hydrological simulation models) 5.4 Describe forecast data outputs (rainfall predictions, flood risk maps, drought indices) 5.5 Explain data collection techniques (satellite imagery, weather stations, river gauges).	hydrological forecasting • Discuss forecasting models (numerical weather prediction, hydrological simulation models) • Explain forecast data outputs (rainfall predictions, flood risk maps, drought indices) • Describe data collection techniques (satellite imagery, weather stations, river gauges).		• Develop simple meteorological and hydrological forecasts using collected data. • Prepare weather and flood warning reports. • Evaluate forecast accuracy using observed data.	hydrographs. • Develop simple meteorological and hydrological forecasts using collected data. • Prepare and communicate weather and flood warning reports. • Evaluate forecast accuracy using observed data.	resource boards. Global datasets from NOAA, NASA Earth Observations, World Meteorological Organization archives.
--	--	---	--	---	---	--

COURSE ASSESSMENT:

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

INTRODUCTION TO HYDROGEOLOGY

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY		
COURSE TITLE: INTRODUCTION TO HYDROGEOLOGY	COURSE CODE: HWR 125	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: II	PRE-REQUISITE:	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with the knowledge and skills of groundwater occurrence, movement, exploration, development, and management for sustainable water resources utilization and environmental protection.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the occurrences of ground water distribution and their uses; 2.0 Know the principles of groundwater investigation/exploration; 3.0 Understand the principles of groundwater exploitation; 4.0 Explore chemical and biological aspects of groundwater, sources of contamination.		

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY						
COURSE TITLE: INTRODUCTION TO HYDROGEOLOGY			COURSE CODE: HWR 125		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: I 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 groundwater occurrence, movement, exploration, development, and management for sustainable water resources utilization and environmental protection.						
General objective 1.0: understand the occurrences of ground water distribution and their uses.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-4	1.1 Explain groundwater occurrence and groundwater distribution 1.2 Outline groundwater uses 1.3 Describe the challenges in groundwater use 1.4 Explain Geological Influence Rock types, soil porosity, and permeability 1.5 Explain how water is stored and moves underground.	• Discuss groundwater occurrence and groundwater distribution • Discuss groundwater uses • Describe the challenges in groundwater use • Explain Geological Influence Rock types, soil porosity, and permeability • Discuss how water is stored and moves underground.	Weather charts and maps GIS software and hydrological modeling tools Computers or tablets with weather apps Field notebooks and log sheets Beakers, flasks, and funnels	• Identify groundwater occurrence in different geological formations. • Classify different types of aquifers. • Assess groundwater distribution using hydrogeological data. • Demonstrate groundwater abstraction methods. • Evaluate	Guide students to: • Identify groundwater occurrence in different geological formations. • Classify different types of aquifers. • Assess groundwater distribution using hydrogeological data. • Demonstrate groundwater abstraction methods. • Evaluate groundwater uses and conservation	Geological maps Rock samples Hydrogeological maps Aquifer models Cross-sectional diagrams Charts Borehole logs Topographic maps GIS software Computer Borehole model Water pump Well model Measuring tape

				groundwater uses and conservation practices.	practices.	
General objective 2.0: know the principles of groundwater investigation/exploration						
5-8	2.1 Outline the factors that affect the movement of water in soils. 2.2 Define aquifers 2.3 List different types of aquifers (aquiclude, aquitard, aquifuge) 2.4 Describe flow patterns in different types of aquifers.	• Explain factors affecting the movement of water in soils. • Explain aquifers • Explain different types of aquifer. • Explain flow patterns in different types of aquifers	Whiteboard, Projector, Screen, Marker.	• Conduct a preliminary groundwater site investigation. • Interpret geological and hydrogeological maps for groundwater exploration. • Demonstrate basic geophysical investigation techniques. • Interpret borehole drilling and pumping test data. • Prepare a groundwater investigation report.	Guide students to: • Conduct a preliminary groundwater site investigation. • Interpret geological and hydrogeological maps for groundwater exploration. • Demonstrate basic geophysical investigation techniques. • Interpret borehole drilling and pumping test data. • Prepare a groundwater investigation report.	Topographic maps GPS Field notebook Compass Geological maps Hydrogeological maps GIS software Computer Resistivity meter Electrodes Measuring tape Field data sheets
General objective 3.0: understand the principles of groundwater exploitation						
9-11	3.1 State the different types of groundwater investigation techniques	• Explain different types of groundwater investigation techniques.	Whiteboard, Projector, Screen, Marker.	• Collect field data from resistivity and other techniques. • Interpret field data	Guide students to: • Demonstrate and collect field data from resistivity and other techniques.	Resistivity meter, cable, battery, computer etc

	3.2 Explain exploration and extraction techniques 3.3 Describe the environmental and social impacts of groundwater	• Explain electrical resistivity, seismic, electro- magnetic field methods and interpretation • Explain the environmental and social impacts of groundwater.		using manual and computer interpretation • Conduct basic tests to determine groundwater	• Interpret field data using manual and computer interpretation • Conduct basic tests to determine groundwater	
General objective 4.0. Explore chemical and biological aspects of groundwater, sources of contamination						
12-15	4.1 Explain the fundamental chemical composition of groundwater 4.2 Describe the role of microorganisms in groundwater systems 4.3 Explain the major sources of groundwater contamination 4.4 Describe monitoring of groundwater quality.	• Discuss the fundamental chemical composition of groundwater • Explain the role of microorganisms in groundwater systems • Discuss the major sources of groundwater contamination • Discuss monitoring of groundwater quality.	Whiteboard, Projector, Screen, Marker.	• Conduct test for major chemical constituents • Assess contaminated microbial communities • Classify contamination sources (industrial, agricultural, domestic, natural)	Guide students to: • Conduct test for major chemical constituents • Assess contaminated microbial communities • Classify contamination sources (industrial, agricultural, domestic, natural)	Water testing kits Agar plates, petri dishes, incubators, and simple microscopes Transparent tanks with sand, gravel, and dye GPS apps or simple maps
COURSE ASSESSMENT: Course work: 10% Test/Assignments: 10%						

Practical:	40%
Examination:	40%
Total:	100%



BASIC PRINCIPLE OF SURVEY

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY		
COURSE TITLE: BASIC PRINCIPLE OF SURVEY	COURSE CODE: HWR 126	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: II	PRE-REQUISITE:	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills required to measure, map, and analyze land features accurately using basic surveying principles, instruments, and techniques for engineering, environmental, and water resources applications		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Know fundamental concepts of Land Survey; 2.0 Understand land survey trigonometry; 3.0 Know basic land survey drawing techniques; 4.0 Understand levelling; 5.0 Understand traversing; 6.0 Understand triangulation; 7.0 Understand tachometry; 8.0 Understand the procedure and methods of third order theodolite and total station traversing; 9.0 Understand the basic principles and methods of using total station and GIS Equipment; 10.0 Understand problems involved in producing contoured plans.		

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY						
COURSE TITLE: BASIC PRINCIPLE OF SURVEY			COURSE CODE: HWR 126		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: II			PRE-REQUISITE:		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills required to measure, map, and analyze land features accurately using basic surveying principles, instruments, and techniques for engineering, environmental, and water resources applications						
General Objective 1.0: Know fundamental concepts of Land Survey						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1	1.1 Define land survey 1.2 Explain the importance of land survey. 1.3 Explain branches of land survey. 1.4 Explain principles of land survey. 1.5 Describe land survey instruments. 1.6 Explain applications of land survey in water resources management	• Explain land survey and its importance. • Discuss branches of land survey. • Explain principles of land survey. • Describe land survey instruments. • Discuss applications of land survey in water resources management	Whiteboard Charts Survey manuals. Survey instruments. Case studies	• Identify surveying instruments and accessories. • Perform simple linear measurements. • Record field observations correctly. • Conduct reconnaissance surveys. • Report findings	Guide students to: • Identify surveying instruments and accessories. • Perform simple linear measurements. • Record field observations correctly. • Conduct reconnaissance surveys. • Record and report findings	Survey equipment. Chains, Tapes. Field books. Campus Survey area Computer
General Objective 2.0: Understand land Survey Trigonometry						

2	2.1 Explain land survey trigonometry. 2.2 Explain trigonometric functions. 2.3 Describe right-angled triangles. 2.4 Describe bearing and azimuth calculations. 2.5 Explain the application of trigonometry in surveying problems	• Discuss land survey trigonometry. • Explain trigonometric functions. • Describe right-angled triangles. • Describe bearing and azimuth calculations. • Explain the application of trigonometry in surveying problems	Whiteboard, calculators. Charts. Worked examples. Survey manuals. Worksheets Computer Projector	• Calculate heights and distances using trigonometric functions. • Determine bearings and azimuths. • Solve practical surveying problems. • Report findings	Guide students to: • Calculate heights and distances using trigonometric functions. • Determine bearings and azimuths. • Record and report findings	Scientific calculators. Compass, Theodolite. Worksheets
General Objective 3.0: Know Basic Land Survey Drawing Techniques						
3	3.1 Describe land survey drawing. 3.2 Explain scales and scale selection. 3.3 Describe drawing symbols and conventions. 3.4 State plotting methods. 3.5 Describe map preparation procedures	• Explain land survey drawing. • Explain scales and scale selection. • Describe drawing symbols and conventions. • Explain plotting methods. • Explain map preparation procedures	Drawing manuals. Scale rulers. Drawing sheets. Charts. Sample maps	• Drawing instruments correctly. • Plot survey data. • Prepare simple survey plans. • Apply appropriate scales and symbols. • Report findings	Guide students to: • Demonstrate drafting techniques. • Guide plotting exercises. • Supervise map preparation. • Demonstrate plan presentation techniques. • Record and report findings	Drawing board, T-square. Graph sheets. Drawing instruments. Survey drawing templates
General Objective 4.0: Understand levelling						
4	4.1 Define leveling 4.2 Explain objectives	• Explain leveling and its objectives.	Textbooks. Survey	• Set up leveling instruments.	Guide students to: • Set up leveling	Automatic level. Level staff.

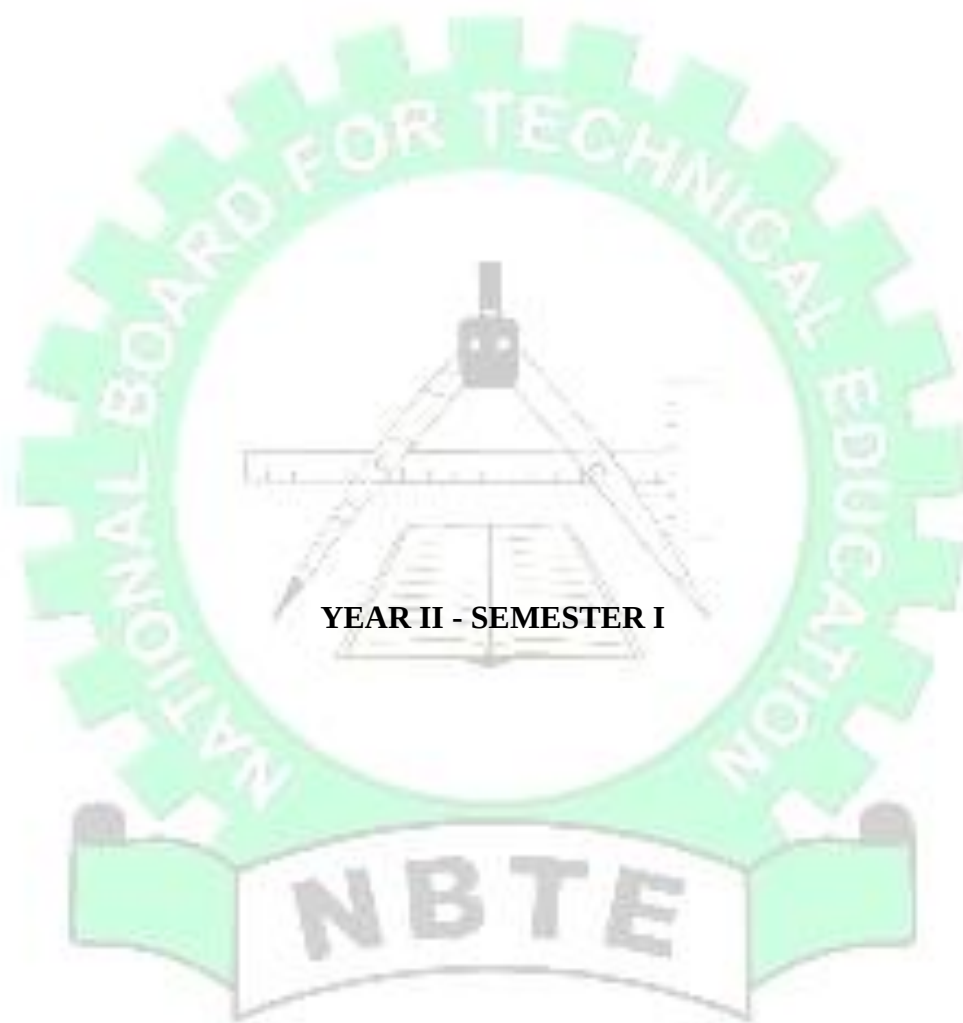
	of levelling. 4.3 Describe leveling instruments. 4.4 Explain methods of leveling. 4.5 Explain reduction of levels. 4.6 Explain errors in leveling	• Describe leveling instruments. • Explain methods of leveling. • Explain reduction of levels. • Discuss errors in leveling	instruments. Diagrams. Worked examples. Survey manuals	• Carry out differential leveling. • Reduce level observations. • Prepare profile and longitudinal sections. • Report findings	instruments. • Carry out differential leveling. • Reduce level observations. • Prepare profile and longitudinal sections. • Record and report findings	Field books. Graph sheets.
General Objective 5.0: Understand Traversing						
5	5.1 Define traversing. 5.2 Explain types of traverses. 5.3 Explain traverse measurements. 5.4 Describe traverse computations. 5.5 Explain adjustment of traverse errors	• Explain traversing. • Explain types of traverses. • Explain traverse measurements. • Describe traverse computations. • Explain adjustment of traverse errors	Survey manuals. Charts. Diagrams. Worksheets.	• Conduct closed traverse surveys. • Measure traverse angles and distances. • Compute coordinates and closures. • Plot traverse plans	Guide students to: • Conduct closed traverse surveys. • Measure traverse angles and distances. • Compute coordinates and closures. • Plot traverse plans	Theodolite, Tapes. Survey instruments. Calculators. Drawing materials
General Objective 6.0: Know Triangulation						
6-7	6.1 Define triangulation. 6.2 Describe triangulation systems. 6.3 Explain baseline measurements. 6.4 Explain angle observations. 6.5 Describe	• Explain triangulation. • Describe triangulation systems. • Explain baseline measurements. • Explain angle observations.	Charts. Diagrams. Survey manuals. Examples. Worksheets	• Establish simple triangulation stations. • Measure baseline and angles. • Compute triangle dimensions. • Plot triangulation networks	Guide students to: • Establish simple triangulation stations. • Measure baseline and angles. • Compute triangle dimensions. • Plot triangulation networks.	Survey pegs. Theodolite. Calculators. Drawing sheets

	triangulation computations	Describe triangulation computations		Record and report findings	Record and report findings	
General Objective 7.0: Understand Tachometry						
8-9	7.1. Define tachometry. 7.2. Describe tachometric instruments. 7.3. Explain stadia measurements. 7.4. Describe tachometric methods. 7.5. Explain advantages and disadvantages of tachometry	- Explain tachometry. - Explain tachometric instruments. - Explain stadia measurements. - Discuss tachometric methods. - Explain advantages and disadvantages of tachometry	Survey equipment. Charts. Manuals. Case studies	- Conduct tachometric observations. - Calculate distances and elevations. - Prepare tachometric survey plans - Record and report findings	Guide students to: - Demonstrate field procedures. - Guide computational exercises. - Supervise drafting exercises. - Record and report findings	Theodolite, staff. Calculators. Drawing materials
GENERAL OBJECTIVE 8.0 Understand the Procedure and Methods of Third-Order Theodolite and Total Station Traversing						
10-11	8.1 Explain third-order traverse standards. 8.2 Describe theodolite traversing procedures. 8.3 Explain total station traversing. 8.4 Describe data recording and processing. 8.5 Explain error detection and adjustment	- Explain third-order traverse standards. - Discuss theodolite traversing procedures. - Explain field observations. - Explain data recording and processing. - Explain error detection and adjustment	Survey standards. Manuals. Equipment manuals. Sample data sheets Worked examples.	- Perform third-order theodolite traversing. - Conduct total station traversing. - Process traverse data. Plot traverse networks. - Record and report findings	Guide students to: - Perform third-order theodolite traversing. - Conduct total station traversing. - Process traverse data. Plot traverse networks. - Record and report findings	Theodolite. Total station. Survey software. Computers

GENERAL OBJECTIVE 9.0: Understand the Basic Principles and Methods of Using Total Station and GIS Equipment						
12-13	9.1.Explain principles of Total Station operation. 9.2.Explain GIS concepts in surveying. 9.3.Describe GIS equipment and software. 9.4.Explain integration of surveying and GIS. 9.5.Describe data export and analysis procedures	• Discuss principles of Total Station operation. • Explain GIS concepts in surveying. • Explain GIS equipment and software. • Explain integration of surveying and GIS. • Describe data export and analysis procedures	Total station manuals. GIS manuals. Computer. Case studies. Software manuals	• Operate Total Station equipment. • Download and process survey data. • Capture spatial data using GIS/GNSS devices. • Create simple GIS maps • Record and report findings	Guide students to: • Operate Total Station equipment. • Download and process survey data. • Capture spatial data using GIS/GNSS devices. • Create simple GIS maps. • Record and report findings	Total station. Computers. GPS receiver. GIS software
GENERAL OBJECTIVE 10.0: Understand Problems Involved in Producing Contoured Plans						
14-15	10.1. Define contouring and contoured plans. 10.2. Explain contour characteristics. 10.3. Describe methods of contouring. 10.4. Explain factors affecting contour accuracy. 10.5. Describe applications of contour maps	• Discuss contouring and contoured plans. • Explain contour characteristics. • Describe methods of contouring. • Explain factors affecting contour accuracy. • Describe applications of contour maps	Topographic maps. Charts. Survey manuals. Examples. Case studies	• Collect spot height data. • Plot contour points. • Draw contour lines accurately. • Produce complete contoured plans • Record and report findings	Guide students to: • Collect spot height data. • Plot contour points. • Draw contour lines accurately. • Produce complete contoured plans, • Record and report findings	Level, Total Station. Graph sheets. Drawing instruments. CAD/GIS software
COURSE ASSESSMENT:						

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





WATER RESOURCES MANAGEMENT I

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY		
COURSE: WATER RESOURCES MANAGEMENT I	COURSE CODE: HWR 211	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 water resources assessment, planning, allocation, water demand management, environmental sustainability, climate resilience, and application of modern water resources management principles		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the scope and concept of water resources management; 2.0 Understand water budget, water balance, and impacts of climate variability; 3.0 Understand water allocation principles and water governance; 4.0 Know urban water demand and water supply requirements; 5.0 Know agricultural water demand and crop water requirements; 6.0 Understand Gender and Social Inclusion in Water Resources Management; 7.0 Understand modern tools and emerging technologies in water resources management.		

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY						
COURSE TITLE: WATER RESOURCES MANAGEMENT I			COURSE CODE: HWR 211		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 equip students with knowledge and skills in water resources assessment, planning, allocation, water demand management, environmental sustainability, climate resilience, and application of modern water resources management principles						
General Objective 1.0: Understand the scope and concept of water resources management.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-2	1.1 Define water resources and water resources management. 1.2 Explain the hydrological cycle. 1.3 Explain Integrated Water Resources Management (IWRM). 1.4 Discuss water resources sustainability. 1.5 Highlight water governance and institutional frameworks in	• Explain water resources and water resources management. • Explain the hydrological cycle. • Explain Integrated Water Resources Management (IWRM). • Discuss water resources sustainability. • Highlight water governance and institutional frameworks in Nigeria	Whiteboard, Marker, Projector, Laptop, Hydrological Charts, Policy Documents	• Identify different water resources. • Identify the hydrological cycle. • Identify the methods of water resources sustainability. • Identify institutions responsible for water management in Nigeria	Guide students to: • Identify different water resources. • Identify the hydrological cycle. • Identify the methods of water resources sustainability. • Identify institutions responsible for water management in Nigeria	Maps, Charts, Multimedia Presentations

	Nigeria 1.6 Explain SDG 6 and its relevance to water resources management.	• Explain SDG 6 and its relevance to water resources management.				
General Objective 2.0: Understand water budget, water balance, and impacts of climate variability.						
3-4	2.1 Describe the origin of water resources 2.2 List the factors that influence the availability of water resources 2.3 Explain water budget and water balance concepts. 2.4 Define catchment yield. 2.5 Explain forms of groundwater occurrence. 2.6 Explain surface water and its forms. 2.7 Explain the impacts of human activities on water balance. 2.8 Explain the impacts of climate	• Describe the origin of water resources • Explain the factors that influence the availability of water resources • Describe water budget and water balance concepts. • Explain catchment yield. • Discuss forms of groundwater occurrence. • Discuss surface water and its forms. • Discuss the impacts of human activities on water balance. • Discuss the impacts of climate change and land use changes on	Whiteboard, Marker, Projector, Laptop, Hydrological Charts, Policy Documents	• Calculate water balance. • Estimate catchment yield. • Analyze climate impacts on water resources	• Take students for excursions to see catchment yield, different forms of surface, ground water resources and the impacts of man in modifying the water balance. Guide students to: • Calculate water balance. • Estimate catchment yield. • Analyze climate impacts on water resources	Excel Software, Data Sheets, Calculators

	change and land use changes on water availability.	water availability.				
General Objective 3.0: Understand water allocation principles and water governance						
5-6	3.1 Explain principles of water allocation. 3.2 Discuss issues in water allocation. 3.3 Explain water rights and policies. 3.4 Explain competing water demands. 3.5 Describe water demand and supply balance. 3.6 Explain conflict management in water resources allocation	• Explain principles of water allocation. • Discuss issues in water allocation. • Explain water rights and policies. • Discuss competing water demands. • Describe water demand and supply balance. • Explain conflict management in water resources allocation	Whiteboard, Marker, Projector, Laptop, Hydrological Charts, Policy Documents	• Estimate water demand and supply balance. • Assess water allocation scenarios.	Take students for excursions to Federal/State water boards for practical exposure to the principles of water allocation and estimate of water demand and supply. Guide students to: • Estimate water demand and supply balance. • Assess water allocation scenarios.	Worksheets, Calculators
General Objective 4.0: Know urban water demand and water supply requirements						
7-8	4.1 Explain determinants of urban water demand. 4.2 Describe urban water demand. 4.3 Explain water	• Explain determinants of urban water demand. • Describe urban water demand. • Explain water pricing principles.	Whiteboard, Marker, Projector, Laptop, Hydrological Charts, Policy	• Conduct water demand surveys. • Estimate water demand for a selected community.	Guide students to: • Conduct water demand surveys. • Estimate water demand for a selected community.	Survey Forms, Spreadsheet Software

	pricing principles. 4.4 Discuss non-revenue water. 4.5 Explain smart metering systems. 4.6 Explain urban water security challenges	• Discuss non-revenue water. • Describe smart metering systems. • Discuss urban water security challenges	Documents			
General Objective 5.0: Know agricultural water demand and crop water requirements						
9-10	5.1 Explain components of agricultural water demand. 5.2 Explain crop water requirements. 5.3 Describe agricultural yield response to water shortage. 5.4 Explain irrigation scheduling. 5.5 Discuss climate-smart irrigation practices. 5.6 Explain deficit irrigation strategies.	• Explain components of agricultural water demand. • Explain crop water requirements. • Determine agricultural yield response to water shortage. • Explain irrigation scheduling. • Discuss climate-smart irrigation practices. • Explain deficit irrigation strategies.	Whiteboard, Marker, Projector, Laptop, Hydrological Charts, Policy Documents	• Identify the components of agricultural water demand. • Determine crop water requirements and yield reduction due to water shortage. • Prepare irrigation schedules.	Guide students to: • Identify the components of agricultural water demand. • Determine crop water requirements and yield reduction due to water shortage. • Prepare irrigation schedules.	Crop Coefficient Tables, Calculators
General Objective 6.0: Understand Gender and Social Inclusion in Water Resources Management						

11-12	6.1 Define gender and social inclusion in water resources management. 6.2 Explain the role of gender in water access, use and management. 6.3 Explain the barriers to equitable access to water resources among women, youth, persons with disabilities and vulnerable groups. 6.4 Explain the importance of stakeholder participation in water resources planning and management. 6.5 Explain gender-responsive and inclusive approaches to water governance. 6.6 Explain the contribution of	• Define gender and social inclusion in water resources management. • Explain the role of gender in water access, use and management. • Discuss the barriers to equitable access to water resources among women, youth, persons with disabilities and vulnerable groups. • Discuss the importance of stakeholder participation in water resources planning and management. • Explain gender-responsive and inclusive approaches to water governance. • Discuss the contribution of women and marginalized groups in community water	Whiteboard, Marker, Projector, Laptop, Hydrological Charts, Policy Documents	• Conduct stakeholder analysis for water projects. • Identify gender and social inclusion issues in community water supply systems. • Develop inclusive water management plans. • Identify participation levels of different social groups in water governance	Guide students to: • Conduct stakeholder analysis for water projects. • Identify gender and social inclusion issues in community water supply systems. • Develop inclusive water management plans. Identify participation levels of different social groups in water governance	Community Survey Forms, Stakeholder Mapping Tools, GPS, Case Study Reports, Field Observation Checklists
-------	--	--	---	---	--	---

	women and marginalized groups in community water management. 6.7 Explain national and international policies promoting gender equality in water resources management	management. • Discuss national and international policies promoting gender equality in water resources management				
General Objective 7.0: Understand modern tools and emerging technologies in water resources management						
13-15	7.1.Explain modern tools and emerging technologies in water resources management. 7.2.Explain GIS, GPS and Remote Sensing applications. 7.3.Explain IoT, SCADA and smart monitoring systems. 7.4.Explain AI, Machine Learning, drones and cloud computing applications.	• Explain modern tools and emerging technologies in water resources management. • Explain GIS, GPS and Remote Sensing applications. • Explain IoT, SCADA and smart monitoring systems. • Explain AI, Machine Learning, drones and cloud computing applications.	Whiteboard, Marker, Projector, Laptop, Hydrological Charts, Policy Documents	• Use GIS, GPS and Remote Sensing for basic mapping. • Operate smart monitoring devices. • Analyse hydrological data using digital software. • Demonstrate drone and cloud-based applications.	Guide students to: • Use GIS, GPS and Remote Sensing for basic mapping. • Operate smart monitoring devices. • Analyse hydrological data using digital software. • Demonstrate drone and cloud-based applications.	GIS software, GPS, computers. IoT kits, sensors, telemetry devices. Excel, HEC-HMS, WEAP, computers. Drone (or simulation), cloud platform, internet.

COURSE ASSESSMENT:

Course work: 10%

Test/Assignments: 10%

Practical: 40%

Examination: 40% = 100%

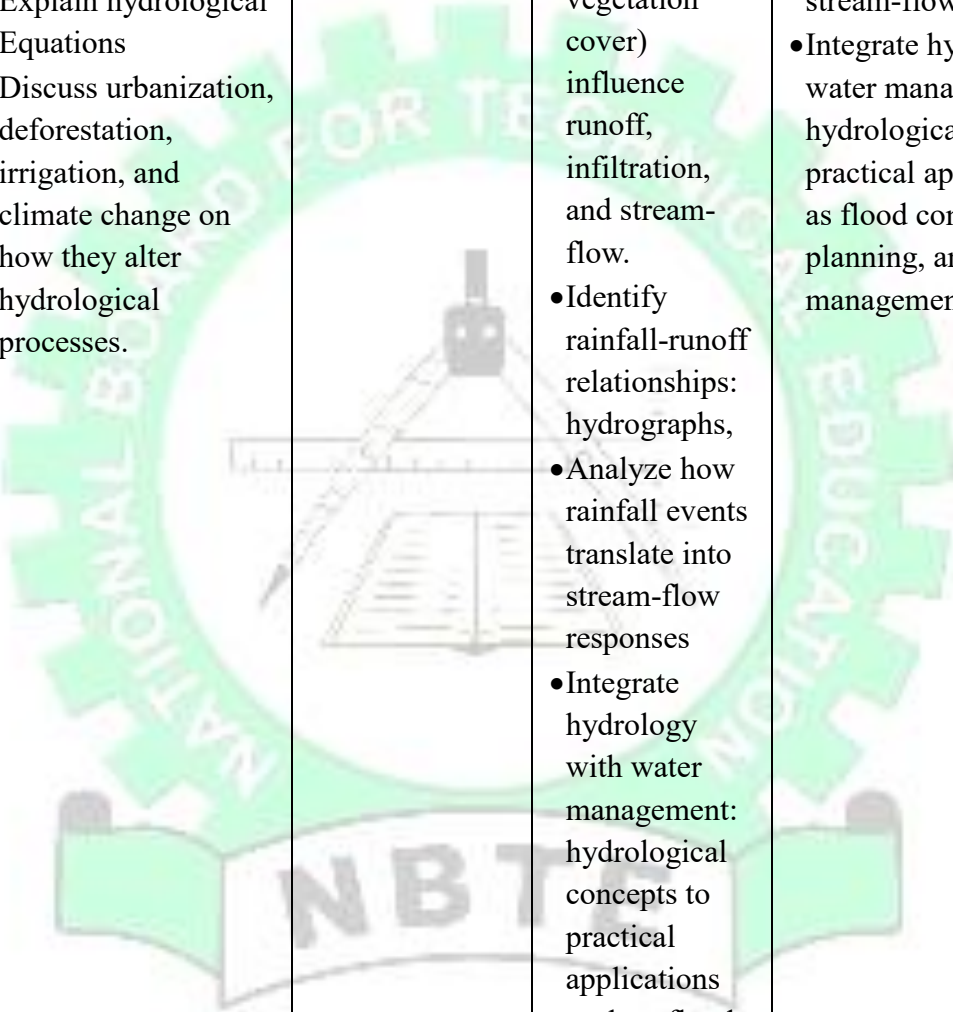


HYDROLOGICAL DATA COLLECTION, PROCESSING AND FIELD METHODS

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY		
COURSE: HYDROLOGICAL DATA COLLECTION, PROCESSING AND FIELD METHODS	COURSE CODE: HWR 212	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 required to collect and process hydrological data		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand fieldwork and conduction of site survey; 2.0 Understand hydrological concepts; 3.0 Operate field equipment and apply modern measurement techniques; 4.0 Understand safety protocols; 5.0 Know how to evaluate field data and Ensure data accuracy; 6.0 Know data organization and application of statistical methods; 7.0 Understand data processing, interpretation and communication of findings.		

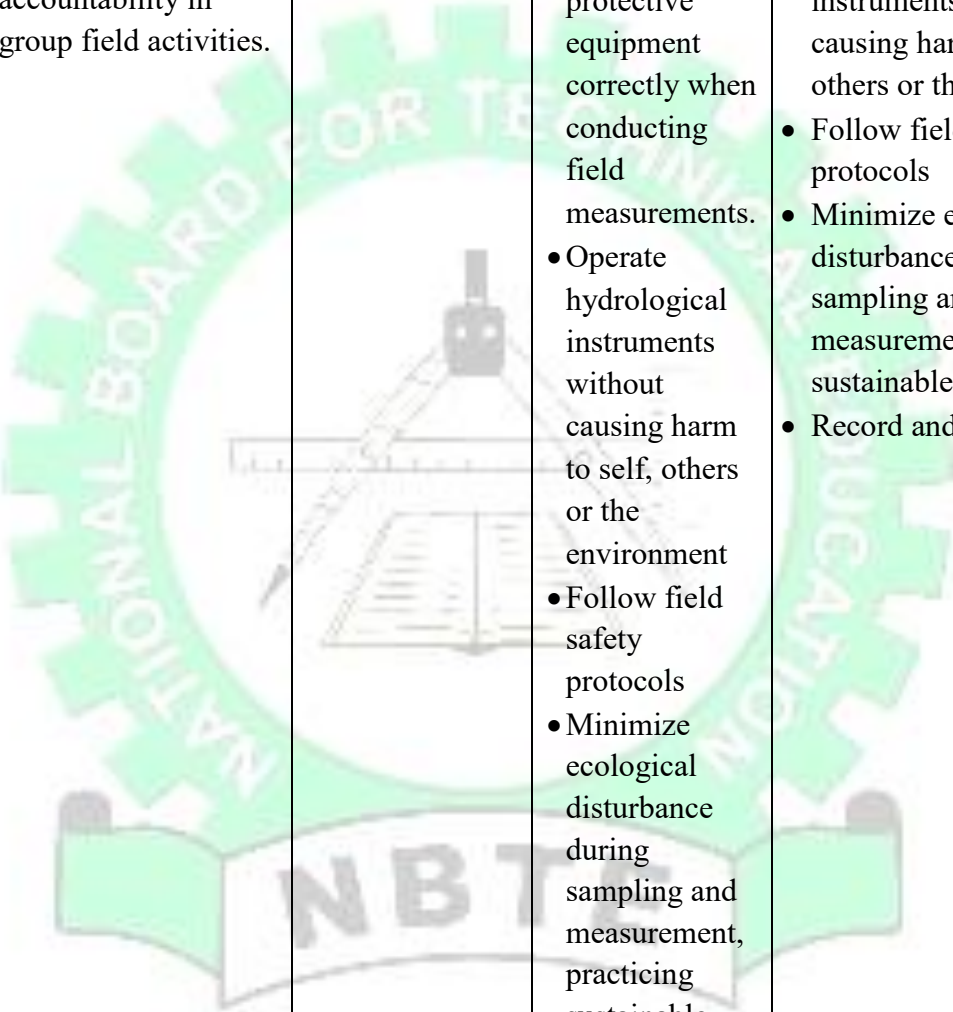
PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY						
COURSE TITLE: HYDROLOGICAL DATA COLLECTION, PROCESSING AND FIELD METHODS			COURSE CODE: HWR 212		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: II SEMESTER: I			PRE-REQUISITE: NIL		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills required to collect and process hydrological data						
General Objective 1.0: Understand fieldwork and conduction of site survey.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-2	1.1 Define hydrological fieldwork in respect to: i. Measuring stream-flow ii. Groundwater levels iii. Water quality. 1.2 Explain the importance of hydrological fieldwork and its applications 1.3 Describe flooding, wildlife, remote	• Explain hydrological fieldwork in respect to: – Measuring stream-flow – Groundwater levels – Water quality. • Explain the importance of hydrological fieldwork and its applications • Discuss flooding,	Textbooks, lecture notes, case studies GIS maps Computer Projector Marker internet	•Identify suitable locations for data collection based on watershed characteristics, accessibility, and safety considerations. •Create step-by-step procedures for data collection, ensuring	Guide students to: •Identify suitable locations for data collection based on watershed characteristics, accessibility, and safety considerations. •Create step-by-step procedures for data collection, ensuring consistency and reliability across different teams • Record and report findings	Rain gauge, current meter, piezometer, water quality kits, GPS devices, PPE GIS software, Hydrological modeling programs (HEC-HMS, SWAT), Mobile data collection apps, Remote sensing

	terrain and prepare safety measures, including emergency response plans. 1.4 Discuss how to design field notebooks, checklists and data sheets to record observations systematically.	wildlife, remote terrain and prepare safety measures, including emergency response plans. • Describe how to design field notebooks, checklists and data sheets to record observations systematically.		consistency and reliability across different teams • Record and report findings		imagery.
General Objective 2.0: Understand hydrological concepts						
3-4	2.1 Explain the hydrological cycle, such as precipitation, infiltration, runoff, evapotranspiration, and groundwater recharge 2.2 Explain hydrology concepts i. Watersheds ii. Groundwater 2.3 Describe water balance components and estimate the input,	• Explain the hydrological cycle, such as precipitation, infiltration, runoff, evapotranspiration, and groundwater recharge • Discuss hydrology concepts – Watersheds – Groundwater • Discuss water balance components and estimate the	Soil infiltration kits Sample cylinders Infiltrimeters Classroom	• Identify how to differentiate hydrological systems, surface water, groundwater, atmospheric water systems, and explain their interactions. • Analyze watershed	Guide students to: • Identify how to differentiate hydrological systems, surface water, groundwater, atmospheric water systems, and explain their interactions. • Analyze watershed (topography, soil type, vegetation cover) influence runoff, infiltration, and stream-flow. • Identify rainfall-runoff relationships: hydrographs,	Water testing kit. Stream gauging tools: Flow meters, Staff gauges, Measuring tapes.

	output and storage. 2.4 Explain hydrological Equations 2.5 Explain urbanization, deforestation, irrigation, and climate change on how they alter hydrological processes.	input, output and storage. • Explain hydrological Equations • Discuss urbanization, deforestation, irrigation, and climate change on how they alter hydrological processes.		(topography, soil type, vegetation cover) influence runoff, infiltration, and stream-flow. • Identify rainfall-runoff relationships: hydrographs, • Analyze how rainfall events translate into stream-flow responses • Integrate hydrology with water management: hydrological concepts to practical applications such as flood control,	• Analyze how rainfall events translate into stream-flow responses • Integrate hydrology with water management: hydrological concepts to practical applications such as flood control, irrigation planning, and groundwater management.	
--	---	---	---	---	--	--

				irrigation planning, and groundwater management.		
General Objective 3.0: Operate field equipment and apply modern measurement techniques						
5-6	3.1 Discuss lab reports, and presentations that communicate results effectively. 3.2 Evaluate limitations and assess the strengths and weaknesses of different measurement techniques and equipment. 3.3 Explain rain gauges, flow meters, infiltrometers, GPS devices and water quality kits. 3.4 Explain Data recording: Ensure students maintain accurate field notes and logs. 3.5 Discuss	• Discuss lab reports, and presentations that communicate results effectively. • Evaluate limitations and assess the strengths and weaknesses of different measurement techniques and equipment. • Explain rain gauges, flow meters, infiltrometers, GPS devices and water quality kits. • Explain Data recording: Ensure students maintain accurate field notes and logs.	Computers Smart board Projector Writing materials, Whiteboard Markers Internet	• Identify the purpose of tools such as: flow meters, infiltrometers, rain gauges and water quality kits. • Operate instruments safely accordingly for measuring streamflow, infiltration, precipitation, and groundwater levels. • Use digital sensors, GPS, and GIS-based	Guide students to: • Identify and describe the purpose of tools such as: flow meters, infiltrometers, rain gauges and water quality kits. • Safely and accurately operate instruments for measuring streamflow, infiltration, precipitation, and groundwater levels. • Use digital sensors, GPS, and GIS-based tools to collect and analyze hydrological data. • Conduct field sampling and measurements with precision, ensuring reproducibility and accuracy. • Record and report findings	Flow meters, Staff gauges Current meters. Manual rain gauges Automated tipping-bucket gauges. Double-ring infiltration devices Portable kits

	measurement accuracy and limitations	• Discuss measurement accuracy and limitations		tools to collect and analyze hydrological data. • Conduct field sampling and measurements with precision, ensuring reproducibility and accuracy. • Report findings		
General Objective 4.0: Understand safety protocols						
7-8	4.1 Define PPE 4.2 Explain emergency preparedness and appropriate response to accidents, injuries unexpected environmental hazards during fieldwork. 4.3 Describe team communication collaboratively, maintaining clear communication	• Explain PPE • Discuss emergency preparedness and appropriate response to accidents, injuries unexpected environmental hazards during fieldwork. • Explain team communication collaboratively,	Emergency Contact List –. Hand. Flashlights and Batteries Emergency Kits	• Identify safety hazards • Recognize potential risks in hydrological fieldwork such as slippery riverbanks, contaminated water, electrical equipment, and weather	Guide students to: • Identify safety hazards • Recognize potential risks in hydrological fieldwork such as slippery riverbanks, contaminated water, electrical equipment, and weather conditions. • Demonstrate the use of personal protective equipment correctly when conducting	First Aid Box Fire Extinguisher – PPE Communication Devices Charts

	and accountability in group field activities.	maintaining clear communication and accountability in group field activities.		conditions. • Use personal protective equipment correctly when conducting field measurements. • Operate hydrological instruments without causing harm to self, others or the environment • Follow field safety protocols • Minimize ecological disturbance during sampling and measurement, practicing sustainable fieldwork.	field measurements. • Operate hydrological instruments without causing harm to self, others or the environment • Follow field safety protocols • Minimize ecological disturbance during sampling and measurement, practicing sustainable fieldwork. • Record and report finding	
--	---	---	---	---	---	--

				• Report finding		
General Objective 5.0: Know how to evaluate field data and ensure data accuracy						
9-10	5.1 Understand how to read, classify, and interpret raw field data 5.2 Explain inconsistencies, biases, or gaps in data collection. 5.3 Describe how to Cross-check field data against secondary sources or baseline studies. 5.4 Explain the use of statistical software, spreadsheets or qualitative coding methods to ensure data accuracy.	• Explain how to read, classify, and interpret raw field data • Explain inconsistencies, biases, or gaps in data collection. • Discuss how to Cross-check field data against secondary sources or baseline studies. • Explain the use of statistical software, spreadsheets or qualitative coding methods to ensure data accuracy.	Textbooks, whiteboard, projector, computer, internet, markers, lecture notes, coursework etc.	• Carry out data reading, classification and interpretation of raw data • Cross check field data against secondary sources or baseline studies • Use statistical software to ensure data analysis and accuracy. • Report findings	Guide students to: • Carry out data reading, classification and interpretation of raw data • Cross check field data against secondary sources or baseline studies • Use statistical software to ensure data analysis and accuracy. • Record and report findings	Flashlights and Batteries Charts Computer Relevant soft wares Baseline studies Available hydrological data
General Objective 6.0: Know data organization and application of statistical methods						
11-12	6.1 Explain data organization and	• Explain data organization and	Textbooks, whiteboard,	• Organize and classify	Guide students to: • Organize and classify	Computers, sample datasets.

	classification. 6.2 Explain statistical methods used in water resources management. 6.3 Explain data presentation and interpretation techniques. 6.4 Explain the application of statistical methods in water resources analysis.	classification. • Explain statistical methods used in water resources management. • Explain data presentation and interpretation techniques. • Explain the application of statistical methods in water resources analysis.	projector, computer, internet, markers, lecture notes, coursework etc.	hydrological data. • Apply descriptive statistical methods to water resources data. • Present data using tables, charts and graphs. • Analyse and interpret water resources data using statistical software.	hydrological data. • Apply descriptive statistical methods to water resources data. • Present data using tables, charts and graphs. • Analyse and interpret water resources data using statistical software.	Calculator, Excel/SPSS. Graph sheets, computers. SPSS/R, sample datasets.
General Objective 7.0: Understand data processing, interpretation and communication of findings						
13-15	7.1. Explain data processing methods. 7.2. Explain techniques for data interpretation. 7.3. Explain methods of presenting and communicating findings.	• Explain data processing methods. • Explain techniques for data interpretation. • Explain methods of presenting and communicating findings. • Explain the	Textbooks, whiteboard, projector, computer, internet, markers, lecture notes, coursework etc.	• Process and organize water resources data. • Interpret analysed hydrological and water quality data.	Guide students to: • Process and organize water resources data. • Interpret analysed hydrological and water quality data. • Prepare tables, charts and graphs for data presentation. • Prepare and present a	Computers, Excel, sample datasets, Statistical Software, sample data, Excel, Power BI, computers, Computers, projector, Report

	7.4.Explain the importance of effective communication in water resources management.	importance of effective communication in water resources management.		• Prepare tables, charts and graphs for data presentation. • Prepare and present a technical report on analysed data.	technical report on analysed data.	templates,
COURSE ASSESSMENT: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% = 100%						

WATERSHED HYDROLOGY AND CATCHMENT MANAGEMENT

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY		
COURSE: WATERSHED HYDROLOGY AND CATCHMENT MANAGEMENT	COURSE CODE: HWR 213	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 of watershed hydrological processes and catchment management.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the fundamental concepts and principles of watershed hydrology and catchment management; 2.0 Know the hydrological cycle and its components, including precipitation, infiltration, evapotranspiration, runoff, groundwater recharge, etc; 3.0 Know the identification and classification of watershed and catchment characteristics affecting hydrological processes; 4.0 Understand rainfall–runoff relationships and watershed response to hydrological events; 5.0 Know the impacts of land use, climate variability, and human activities on watershed hydrology; 6.0 Understand soil erosion, sediment transport, and watershed degradation processes; 7.0 Understand methods for flood control, drought mitigation, and water conservation within catchments; 8.0 Know the relevant policies, regulations, and institutional frameworks governing watershed management.		

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY						
COURSE TITLE: WATERSHED HYDROLOGY AND CATCHMENT MANAGEMENT			COURSE CODE: HWR 213		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 equip students with knowledge and skills of watershed hydrological processes and catchment management.						
General Objective 1.0: Understand the fundamental concepts and principles of watershed hydrology and catchment management.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1	1.1 Define watershed, catchment, drainage basin, and related hydrological terms. 1.2 Describe the components and processes of the hydrologic cycle within a watershed. 1.3 Explain watershed characteristics, including topography, soil, land use, vegetation, and drainage networks.	• Explain watershed, catchment, drainage basin, and related hydrological terms. • Discuss the components and processes of the hydrologic cycle within a watershed. • Explain watershed characteristics, including topography, soil, land use, vegetation, and drainage networks. • Discuss the principles	Computer, Smart board, White board, Projector, Marker, , Internet	• Delineate watersheds and catchment boundaries using topographic maps and GIS tools. • Identify watershed physical characteristics affecting hydrological processes. • Analyze watershed physical characteristics affecting	Guide students to: • Delineate watersheds and catchment boundaries using topographic maps and GIS tools. • Identify watershed physical characteristics affecting hydrological processes. • Analyze watershed physical characteristics	Computer Projector Hydrological charts Catchment models

	1.4 Discuss the principles of watershed hydrology and their importance in water resources management.	of watershed hydrology and their importance in water resources management.		hydrological processes. • Measure basic hydrological parameters within a watershed. • Interpret basic hydrological parameters within a watershed. • Analyze rainfall, streamflow, and other hydrological data for catchment assessment. • Calculate watershed metrics such as area, slope, drainage density, stream order, and runoff coefficient. • Record and report findings.	affecting hydrological processes. • Measure basic hydrological parameters within a watershed. • Interpret basic hydrological parameters within a watershed. • Analyze rainfall, streamflow, and other hydrological data for catchment assessment. • Calculate watershed metrics such as area, slope, drainage density, stream order, and runoff coefficient. • Record and report findings.	
General Objective 2.0: Know the hydrological cycle and its components, including precipitation, infiltration, evapotranspiration, runoff, groundwater recharge, etc						
2-3	2.1 Define the	• Define the	Laptop	• Draw the	Guide students to:	Computer

	hydrological cycle 2.2 Explain its significance in water resources management. 2.3 Describe the major components of the hydrological cycle. 2.4 Explain the processes of precipitation and the different forms in which it occurs. 2.5 Describe the factors influencing infiltration and soil-water movement. 2.6 Explain the concepts and processes of evaporation, transpiration, and evapotranspiration 2.7 Distinguish between surface runoff, subsurface runoff, and	hydrological cycle and discuss its significance in water resources management. • Describe the major components of the hydrological cycle. • Explain the processes of precipitation and the different forms in which it occurs. • Describe the factors influencing infiltration and soil-water movement. • Explain the concepts and processes of evaporation, transpiration, and evapotranspiration. • Distinguish between surface runoff, subsurface runoff, and groundwater flow.	Computers, Smart board, White board, Projector, Marker, Duster, Internet	components of the hydrological cycle using diagrams and flow charts. • Measure precipitation data from rain gauges and meteorological records • Analyze precipitation data from rain gauges and meteorological records. • Determine infiltration rates using standard field or laboratory methods. • Estimate evaporation and evapotranspiration using appropriate techniques and meteorological data. • Analyze runoff data • Identify factors affecting runoff	• Draw and label the components of the hydrological cycle using diagrams and flow charts. • Measure precipitation data from rain gauges and meteorological records • Analyze precipitation data from rain gauges and meteorological records. • Determine infiltration rates using standard field or laboratory methods. • Estimate evaporation and evapotranspiration using appropriate techniques and meteorological data. • Analyze runoff data • Identify factors affecting runoff generation. • Record and report	Meteorological station Projector
--	--	---	---	--	--	---

	groundwater flow.			generation. • Record and report findings.	findings.	
General Objective 3.0: Know the identification and classification of watershed and catchment characteristics affecting hydrological processes						
4-5	3.1 Define watershed and catchment characteristics 3.2 Explain their importance in hydrological studies. 3.3 State the major physiographic characteristics of a watershed, including area, shape, slope, relief, drainage pattern, etc. 3.4 Explain the classification of drainage networks based on stream order and drainage density.	• Define watershed and catchment characteristics • Explain their importance in hydrological studies. • Explain the major physiographic characteristics of a watershed, including area, shape, slope, relief, drainage pattern, etc. • Discuss the classification of drainage networks based on stream order and drainage density.	Laptop Computers, Smart board, White board, Projector, Marker, duster, Internet	• Delineate watershed and catchment boundaries using topographic maps and GIS tools. • Determine watershed area, perimeter, basin length, and average slope from maps and spatial data. • Classify watershed shape using morphometric indices. • Calculate drainage density and stream frequency from drainage network data. • Record and report	Guide the student to: • Delineate watershed and catchment boundaries using topographic maps and GIS tools. • Determine watershed area, perimeter, basin length, and average slope from maps and spatial data. • Classify watershed shape using morphometric indices. • Calculate drainage density and stream frequency from drainage network data • Record and report findings.	Laptop, Laboratory Equipment, Instruments, Writing materials, Projector

				findings.		
General Objective 4.0: Understand rainfall–runoff relationships and watershed response to hydrological events.						
6-7	4.1 Define rainfall, runoff, infiltration, evapotranspiration, and watershed response. 4.2 Explain the components of the hydrologic cycle and their influence on runoff. 4.3 Describe the relationship between rainfall characteristics (intensity, duration, frequency, and distribution) and runoff production.	- Define rainfall, runoff, infiltration, evapotranspiration, and watershed response. - Explain the components of the hydrologic cycle and their influence on runoff. - Describe the relationship between rainfall characteristics (intensity, duration, frequency, and distribution) and runoff production.	Laptop Computers, Smart board, White board, Projector, Marker, Internet	- Analyze rainfall and runoff data from hydrological records. - Interpret rainfall hyetographs and runoff hydrographs. - Estimate runoff volumes and peak flows using appropriate hydrological methods. - Calculate watershed characteristics such as area, slope, drainage density, and runoff coefficient. - Report findings.	Guide the students to: - Analyze rainfall and runoff data from hydrological records. - Construct and interpret rainfall hyetographs and runoff hydrographs. - Estimate runoff volumes and peak flows using appropriate hydrological methods. - Calculate watershed characteristics such as area, slope, drainage density, and runoff coefficient - Record and report findings	Laptop, Laboratory Equipment, Instruments, Writing materials, Projector
General Objective 5.0: Know the impacts of land use, climate variability, and human activities on watershed hydrology						
8-9	5.1 Explain how different land-use types influence	Explain how different land-use types influence watershed	Laptop Computers, Smart board,	Analyze land-use and land-cover data to assess watershed	Guide the student to: Analyze land-use and land-cover data to	Laptop, Laboratory Equipment,

	watershed hydrological processes. 5.2 Describe the effects of urbanization on infiltration, runoff, groundwater recharge, and flood generation. 5.3 Discuss the impacts of deforestation and vegetation removal on watershed hydrology. 5.4 Explain the influence of agricultural activities on soil erosion, sediment transport, and water quality. 5.5 Describe the concepts of climate variability and climate change and their	hydrological processes. • Describe the effects of urbanization on infiltration, runoff, groundwater recharge, and flood generation. • Discuss the impacts of deforestation and vegetation removal on watershed hydrology. • Explain the influence of agricultural activities on soil erosion, sediment transport, and water quality. • Describe the concepts of climate variability and climate change and their effects on hydrological systems.	White board, Projector, Marker, duster, Internet	changes over time. • Interpret climatic and hydrological datasets to identify trends and variability. • Assess the impacts of urbanization on runoff, infiltration, and peak discharge. • Evaluate the effects of agricultural practices on watershed hydrology and water quality. • Quantify changes in hydrological response resulting from land-use modifications. • Report findings.	assess watershed changes over time. • Interpret climatic and hydrological datasets to identify trends and variability. • Assess the impacts of urbanization on runoff, infiltration, and peak discharge. • Evaluate the effects of agricultural practices on watershed hydrology and water quality. • Quantify changes in hydrological response resulting from land-use modifications. • Record and report findings.	Instruments, Writing materials, Projector
--	---	---	---	---	---	--

	effects on hydrological systems.					
General Objective 6.0: Understand soil erosion, sediment transport, and watershed degradation processes						
10-11	6.1 Differentiate between the distinct mechanics of soil detachment, transport, and deposition by wind and water. 6.2 Explain the sub-processes of water erosion, specifically distinguishing between splash, sheet, rill, inter-rill, and gully erosion. 6.3 Explain the primary environmental drivers of erosion, including rainfall erosivity, soil erodibility, slope gradient/length,	• Differentiate between the distinct mechanics of soil detachment, transport, and deposition by wind and water. • Discuss the sub-processes of water erosion, specifically distinguishing between splash, sheet, rill, inter-rill, and gully erosion. • Discuss the primary environmental drivers of erosion, including rainfall erosivity, soil erodibility, slope gradient/length, and land-use cover.	Laptop Computers, Smart board, White board, Projector, Marker, duster, Internet	• Conduct rapid catchment assessments to locate active erosion hotspots. • Simulate the volume of sediment moving through a watershed and predicting its final deposition site. • Identify specific interventions to interrupt the detachment-transport-deposition cycle. • Record and report findings.	Guide the students to: • Conduct rapid catchment assessments to locate active erosion hotspots. • Simulate the volume of sediment moving through a watershed and predicting its final deposition site. • Identify specific interventions to interrupt the detachment-transport-deposition cycle. • Record and report findings.	Laptop, Laboratory Equipment, Instruments, Writing materials, Projector

	and land-use cover.					
General Objective 7.0: Understand methods for flood control, drought mitigation, and water conservation within catchments						
12-13	7.1 Explain the methods for evaluating flood controls. 7.2 Explain draught mitigation measures. 7.3 Explain how can water be conserved within catchments.	• Explain the methods for evaluating flood controls. • Discuss draught mitigation measures. • Discuss how can water be conserved within catchments.	Laptop Computers, Smart board, White board, Projector, Marker, Internet	• Design Watershed Conservation Structures • Calculate size • Propose structural and non-structural management interventions (e.g., check dams, terracing, riparian buffer zones, and rainwater harvesting systems) to mitigate erosion and optimize water retention • Report findings.	Guide the students to: • Design Watershed Conservation Structures • Calculate size • Propose structural and non-structural management interventions (e.g., check dams, terracing, riparian buffer zones, and rainwater harvesting systems) to mitigate erosion and optimize water retention • Record and report findings.	Laptop, Laboratory Equipment, Instruments, Writing materials, Projector
General Objective 8.0: Know the relevant policies, regulations, and institutional frameworks governing watershed management						
14-15	8.1 Explain the relevant policies governing watershed management	• Explain the relevant policies Governing watershed management • Describe the	Computers, Smart board, White board, Projector, Marker, duster,	• Develop sustainable catchment management plans that integrate:	Guide students to: • Develop sustainable catchment management plans that integrate:	Computer Projector

	8.2 Explain the regulations governing watershed management. 8.3 Explain the institutional frameworks governing watershed management	regulations Governing watershed management. • Discuss the institutional frameworks governing watershed management	Internet	– Environmental, – Social, – Economic considerations. • Report findings.	– Environmental, – Social, – Economic considerations. • Record and report findings.	
COURSE ASSESSMENT: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% = 100%						

WATER QUALITY ASSESSMENT AND POLLUTION CONTROL

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY		
COURSE: WATER QUALITY ASSESSMENT AND POLLUTION CONTROL	COURSE CODE: HWR 214	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 to assess and monitor water quality, control water pollution, and promote the sustainable management and protection of water resources.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand physical properties of water; 2.0 Understand chemical properties of water; 3.0 Understand parameter and categories of water quality; 4.0 Understand methods of water sample collection for water quality analysis; 5.0 Understand methods in water quality analysis; 6.0 Understand water pollution, sources of pollution and control; 7.0 Understand water borne diseases and control measures.		

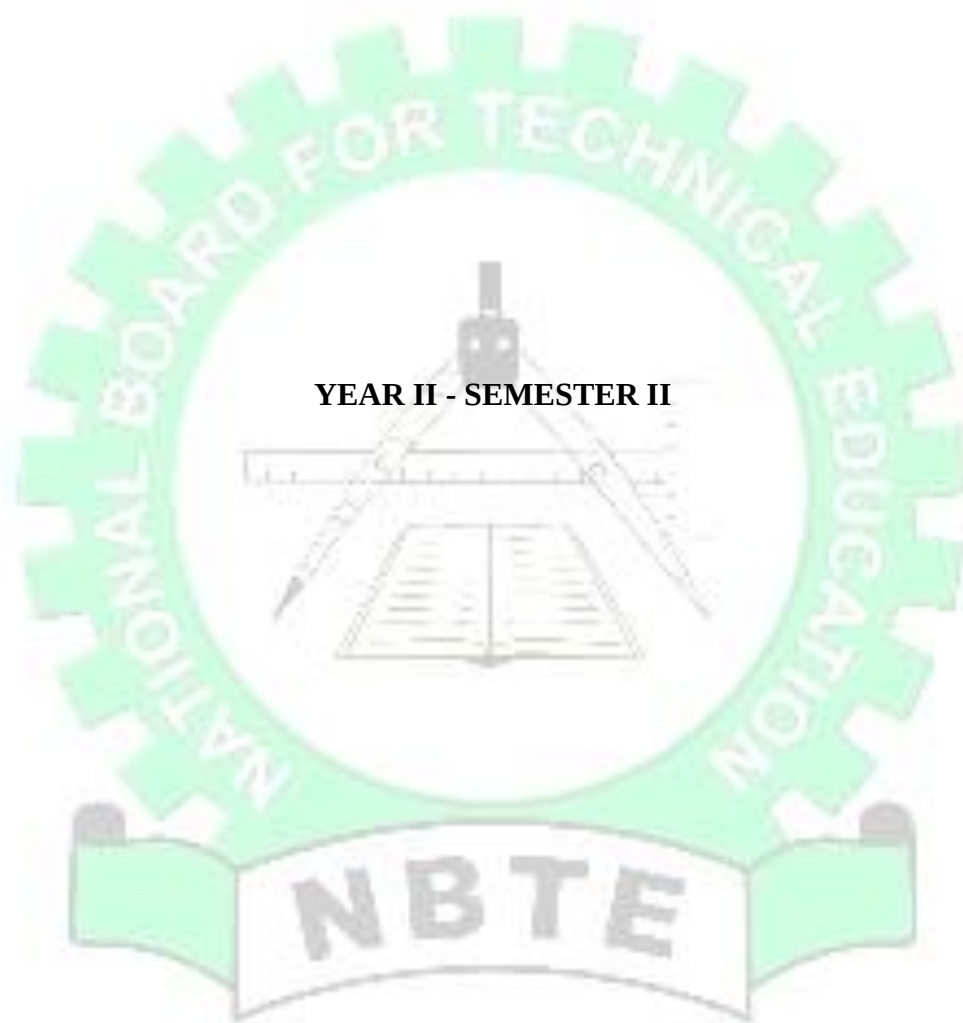
PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY						
COURSE TITLE: WATER QUALITY ASSESSMENT AND POLLUTION CONTROL			COURSE CODE: HWR 214		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: II SEMESTER: I			PRE-REQUISITE: NIL		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills to assess and monitor water quality, control water pollution, and promote the sustainable management and protection of water resources.						
General Objective 1.0: Understand physical properties of water.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-2	1.1 Define physical properties of water. 1.2 State the physical properties of water. 1.3 Explain the significance of physical properties in water use. 1.4 Describe factors affecting physical water quality	• Explain the concept and importance of physical properties in water quality assessment. • Discuss temperature, colour, odour, taste, turbidity, conductivity and total solids. • Illustrate effects of physical parameters on domestic, industrial and agricultural uses.	Whiteboard, charts, textbooks. Samples of water, multimedia presentations. Case studies, water quality manuals. Charts, videos	• Measure temperature of water samples. • Determine turbidity of water samples. • Assess colour, taste and odour. • Measure conductivity and total dissolved solids	Guide students to: • Measure temperature of water samples. • Determine turbidity of water samples. • Assess colour, taste and odour. • Measure conductivity and total dissolved solids Record and report findings. • Record and report findings	Thermometer. Turbidity meter. Water samples. Conductivity meter, TDS meter

		• Explain natural and anthropogenic influences on water quality				
General Objective 2.0: Understand chemical properties of water						
3-4	2.1 Define chemical properties of water. 2.2 Explain major chemical parameters. 2.3 Explain the importance of chemical parameters. 2.4 Describe sources of chemical contaminants	• Explain chemical characteristics and their significance. • Discuss pH, alkalinity, hardness, dissolved oxygen, BOD, COD and nutrients. • Relate parameters to water quality standards. • Explain natural and human-induced contamination	Whiteboard, textbooks. Charts, laboratory manuals. WHO guidelines, manuals. Videos, case studies	• Measure pH of water samples. • Determine alkalinity and hardness. • Analyze dissolved oxygen. • Determine BOD and COD	Guide students to: • assure pH of water samples. • Determine alkalinity and hardness. • Analyze dissolved oxygen. • Determine BOD and COD. • Record and report findings	pH meter. Laboratory reagents and glassware. DO meter, reagents. Incubator, COD digester
General Objective 3.0: Understand parameter and categories of water quality						
5-6	3.1 Define water quality parameters. 3.2 Explain the classification of water quality categories. 3.3 Explain water	• Explain physical, chemical and biological parameters. • Discuss potable, recreational,	Textbooks, charts. Water quality standards. Manuals, presentations. Regulatory	• Classify water samples based on quality parameters. • Calculate simple water quality indices. • Interpret laboratory	Guide students in: • Classify water samples based on quality parameters. • Calculate simple water quality indices.	Water samples, standards manuals. Calculators, worksheets. Laboratory reports

	quality indices. 3.4 Describe water quality standards	irrigation and industrial water quality standards. • Explain concepts of water quality rating and classification. • Explain WHO and Nigerian standards	documents	results • Record and report findings	• Interpret laboratory results. • Record and report findings	
General Objective 4.0: Understand methods of water sample collection for water quality analysis.						
7-8	4.1 Define water sampling. 4.2 Describe sampling techniques. 4.3 Explain sampling procedures. 4.4 Describe sample preservation methods	• Explain principles and objectives of sampling. • Discuss grab, composite and integrated sampling methods. • Describe sample collection protocols. • Explain storage and transportation requirements	Whiteboard, manuals. Charts, videos. Sampling manuals. Preservation guidelines	• Collect water samples from different sources. • Label and preserve samples correctly. • Prepare field records and chain of custody forms. • Transport samples for laboratory analysis	Guide students to: • Collect water samples from different sources. • Label and preserve samples correctly. • Prepare field records and chain of custody forms. • Transport samples for laboratory analysis. • Record and report findings	Sampling bottles. Labels, preservatives. Field notebooks, forms. Ice chest, coolers
General Objective 5.0: Understand methods in water quality analysis						
9-10	5.1 Explain water quality analysis	• Discuss physical, chemical and	Laboratory manuals.	• Perform physical water quality tests.	Guide students to: • Perform physical	Water testing equipment.

	methods. 5.2 Describe laboratory equipment used in water analysis. 5.3 Explain quality assurance and quality control procedures. 5.4 Describe data interpretation methods	biological analyses. • Explain functions and operating principles. • Discuss accuracy, precision and calibration. • Explain result evaluation and reporting.	Laboratory equipment. QA/QC manuals. Sample reports	• Conduct chemical analyses. • Carry out microbiological analysis. • Prepare laboratory reports	water quality tests. • Conduct chemical analyses. • Carry out microbiological analysis. • Prepare laboratory reports	Reagents and apparatus. Incubator, petri dishes. Laboratory worksheets
General Objective 6.0: Understand water pollution, sources of pollution and control						
11-12	6.1 Define water pollution. 6.2 State the sources of water pollution. 6.3 Explain effects of water pollution. 6.4 Describe pollution control measures	• Explain concepts and types of pollution. • Discuss domestic, industrial and agricultural pollution. • Discuss environmental and public health impacts. • Explain prevention and treatment strategies	Textbooks, charts. Videos, case studies. Multimedia presentations. Pollution control manuals	• Identify pollution sources in the field. • Evaluate pollution control measures. • Prepare pollution assessment reports	Guide students to: • Identify pollution sources in the field. • Evaluate pollution control measures. • Prepare pollution assessment reports Supervise report writing exercises	Field checklist. Test kits. Treatment plant models. Report templates
General Objective 7.0: Understand water borne diseases and control measures						
13-15	7.1 Define water-borne diseases.	• Explain disease transmission	• Textbooks, health	• Conduct sanitary inspections.	Guide students to: • Conduct sanitary	Inspection checklist.

	7.2 State common water-borne diseases. 7.3 Explain causes and symptoms. 7.4 Describe prevention and control measures	through water. • Discuss cholera, typhoid, dysentery, hepatitis and diarrhea. • Describe disease development and health effects. • Discuss water treatment, sanitation and hygiene practices	manuals. • Charts, videos. • Medical guides. • WHO publications	• Test water for microbial contamination. • Demonstrate household water treatment methods. • Develop community awareness programmes • Report findings	inspections. • Test water for microbial contamination. • Demonstrate household water treatment methods. • Develop community awareness programmes • Record and report findings	Microbiology laboratory. Water filters, chlorine. Posters, pamphlets
COURSE ASSESSMENT: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% = 100%						



WATER RESOURCES MANAGEMENT II

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY		
COURSE TITLE: WATER RESOURCES MANAGEMENT II	COURSE CODE: HWR 221	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 in water resources development, hydrological processes, groundwater and surface water assessment, water quality monitoring, modelling, and sustainable water resources management.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand water resources development and management; 2.0 Understand drainage basin analysis and watershed management; 3.0 Understand surface hydrological processes and hydrological measurements; 4.0 Understand groundwater resources development and management; 5.0 Understand surface water resources and water quality management; 6.0 Understand Environmental Water Requirements (EWR); 7.0 Understand climate change impacts and water resources modelling.		

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY						
COURSE TITLE: WATER RESOURCES MANAGEMENT II			COURSE CODE: HWR 221		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 in water resources development, hydrological processes, groundwater and surface water assessment, water quality monitoring, modelling, and sustainable water resources management.						
General Objective 1.0: Understand Water Resources Development and Management						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-2	1.1 Define water resources development. 1.2 Define water resources management. 1.3 Differentiate between development, planning and management. 1.4 Explain Principles of Integrated Water Resources Management (IWRM). 1.5 Explain approaches	• Explain water resources development. • Discuss water resources management. • Differentiate between development, planning and management. • Explain Principles of Integrated Water Resources Management (IWRM). • Explain approaches	Whiteboard, Projector, Laptop, National Water Policy Documents, Charts	• Identify major water resources development projects in Nigeria. • Assess challenges affecting project implementation, Basin planning and management. • Evaluate project performance and sustainability.	• Identify major water resources development projects in Nigeria. • Assess challenges affecting project implementation, Basin planning and management. • Evaluate project performance and sustainability.	Project Reports, Maps, Multimedia and Internet Resources

	to water resources development and management. 1.6 Describe the advantages and disadvantages of each of the approaches. 1.7 Describe the problems of water resources development and management in Nigeria. 1.8 Explain the National Water Policy and institutional arrangements.	to water resources development and management. • Explain the advantages and disadvantages of each of the approaches. • Explain the problems of water resources development and management in Nigeria. • Explain the National Water Policy and institutional arrangements.				
General Objective 2.0: Understand Drainage Basin Analysis and Watershed Management						
3-4	2.1 Define drainage basin and watershed. 2.2 Describe drainage basin features, characteristics and functions. 2.3 Explain drainage patterns and stream ordering system.	• Explain drainage basin and watershed. • Discuss drainage basin features, characteristics and functions. • Explain drainage patterns and stream ordering system. • Explain	Topographic Maps, GIS Software, Whiteboard marker, Duster, Laptop, Video tabs, Projector	• Delineate watersheds. • Calculate Morphometric parameters i.e drainage density, stream frequency and bifurcation ratio. • Interpret watershed	Guide students to: • Delineate watersheds. • Calculate Morphometric parameters i.e drainage density, stream frequency and bifurcation ratio. • Interpret watershed	ChaQGIS, ArcGIS, Topographic Maps

	2.4 Describe morphometric parameters/indices using topographical maps or GIS software. 2.5 Explain watershed management principles. 2.6 Assess land-use impacts on watershed hydrology. 2.7 Enumerate the relevance of drainage basin to National development using river basins as case studies	morphometric parameters/indices using topographical maps or GIS software. • Explain watershed management principles. • Explain land-use impacts on watershed hydrology. • Discuss the relevance of drainage basin to National development using river basins as case studies		characteristics. • Assess watershed conditions. • Visit to River Basin Development Authority.	characteristics. • Assess watershed conditions. • Visit to River Basin Development Authority.	
General Objective 3.0: Understand Surface Hydrological Processes and Measurements						
5-6	3.1 Define surface hydrological processes - precipitation, interception, infiltration, evaporation and	• Explain surface hydrological processes - precipitation, interception, infiltration, evaporation and	Whiteboard, Hydrological Charts, Projector, Laptop	• Measure rainfall, infiltration and runoff. • Determine evaporation and evapotranspiration	Guide students to: • Measure rainfall, infiltration and runoff. • Determine evaporation and	Rain Gauge, Infiltrometer, Measuring Cylinders, Field Equipment

	evapotranspiration and runoff. 3.2 Differentiate between surface runoff quick flow delayed runoff. 3.3 Describe the types of hydrological process. 3.4 Explain factors influencing surface hydrological processes. 3.5 Identify sources and components of runoff (channel precipitation, overland flow, thorough flow, and ground flow) 3.6 Explain flood generation mechanisms and flood routing concepts.	evapotranspiration and runoff. • Differentiate between surface runoff quick flow delayed runoff. • Explain the types of hydrological process. • Explain factors influencing surface hydrological processes. • Explain sources and components of runoff (channel precipitation, overland flow, thorough flow, and ground flow) • Explain flood generation mechanisms and flood routing concepts.		rates using appropriate instruments. • Estimate evapotranspiration and runoff coefficients.	evapotranspiration rates using appropriate instruments. • Estimate evapotranspiration and runoff coefficients.	
General Objective 4.0: Understand Groundwater Resources Development and Management						
7-8	4.1 Define groundwater	• Explain	Groundwater	• Measure	Guide students to:	Water Level

	resources. 4.2 Explain groundwater occurrence and formation. 4.3 Describe aquifers, aquicludes and aquitards. 4.4 Explain groundwater recharge and discharge mechanisms. 4.5 Describe the causes of groundwater contamination 4.6 Explain groundwater protection and management. 4.7 Describe groundwater development challenges and management in Nigeria.	groundwater resources. • Explain groundwater occurrence and formation. • Discuss aquifers, aquicludes and aquitards. • Explain groundwater recharge and discharge mechanisms. • Discuss the causes of groundwater contamination • Explain groundwater protection and management. • Discuss groundwater development challenges and management in Nigeria.	Maps, Whiteboard, Projector	groundwater levels. • Conduct borehole inventory. • Assess groundwater quality and vulnerability. • Visit to a Borehole drilling site	• Measure groundwater levels. • Conduct borehole inventory. • Assess groundwater quality and vulnerability. • Visit to a Borehole drilling site	Indicator, GPS, Sampling Bottles
General Objective 5.0: Understand Surface Water Resources and Water Quality Management						

9-10	5.1 Define surface water resources. 5.2 Explain river, lake and reservoir systems. 5.3 Differentiate between overland flow and stream flow. 5.4 Describe sources and types of surface water pollution. 5.5 Explain water quality standards and guidelines. 5.6 Explain impacts of pollution on ecosystems and public health. 5.7 Discuss surface water pollution prevention and control measures.	• Explain surface water resources. • Explain river, lake and reservoir systems. • Differentiate between overland flow and stream flow. • Explain sources and types of surface water pollution. • Explain water quality standards and guidelines. • Discuss impacts of pollution on ecosystems and public health. • Discuss surface water pollution prevention and control measures.	Water Quality Guidelines, Whiteboard, Projector	• Collect water samples. • Measure selected water quality parameters like pH, EC, TDS, Turbidity, DO, BOD, COD and TSS. • Analyse and interpret laboratory results. • Visit water treatment plant.	Guide students to: • Collect water samples. • Measure selected water quality parameters like pH, EC, TDS, Turbidity, DO, BOD, COD and TSS. • Analyse and interpret laboratory results. • Visit water treatment plant.	Water Quality kit, Sampling Bottles, Laboratory Equipment
General Objective 6.0: Understand Environmental Water Requirements						
11-12	6.1 Define environmental water requirement (EWR)	• Explain environmental water requirement (EWR) • Differentiate	White board, Marker, Duster, Video tabs , Overhead	• Identify ecological indicators of environmental water needs.	Guide students to: • Identify ecological indicators of environmental water	Streamflow Data, Hydrological Records, GPS,

	6.2 Differentiate components of environmental water requirements (EWR) 6.3 Explain the concept and importance of environmental flows in river ecosystems. 6.4 Explain the methods of quantifying environmental water requirements 6.5 Describe the components of environmental water requirements including ecological, hydrological, social, cultural, and economic needs. 6.6 Explain the relationship between environmental flows, biodiversity conservation and ecosystem health.	components of environmental water requirements (EWR) • Explain the concept and importance of environmental flows in river ecosystems. • Explain the methods of quantifying environmental water requirements • Discuss the components of environmental water requirements including ecological, hydrological, social, cultural, and economic needs. • Explain the relationship between environmental flows, biodiversity conservation and ecosystem health.	projector Environmental Flow Guidelines, River Basin Reports, Case Study Materials, Charts and Maps	• Estimate environmental flow requirements using simple hydrological methods. • Assess the impacts of water abstraction on river ecosystems. • Interpret environmental flow data and reports. • Evaluate environmental conditions of selected rivers or wetlands.	needs. • Estimate environmental flow requirements using simple hydrological methods. • Assess the impacts of water abstraction on river ecosystems. • Interpret environmental flow data and reports. • Evaluate environmental conditions of selected rivers or wetlands.	Measuring Tape, Flow Meter/Current Meter, Field Data Sheets, Water Quality Testing Kits, Computers with Spreadsheet Software
General Objective 7.0: Understand Climate Change Impacts and Water Resources Modelling						

13-15	7.1.Explain climate change and climate variability. 7.2.Assess impacts of climate change on water resources. 7.3.Explain drought and flood risks. 7.4.Explain climate adaptation and resilience strategies. 7.5.Describe water resources modelling concepts and applications.	• Explain climate change and climate variability. • Explain impacts of climate change on water resources. • Explain drought and flood risks. • Explain climate adaptation and resilience strategies. • Discuss water resources modelling concepts and applications.	Climate Reports, Computer Laboratory, Projector	• Analyze rainfall trends. • Perform flood frequency analysis. • Interpret model outputs.	Guide students to: • Analyze rainfall trends. • Perform flood frequency analysis. • Interpret model outputs.	Climate Data Sets, Excel Software
COURSE ASSESSMENT: Course work 10% Test/Assignments 10% Practical 40% Examination 40% = 100%						

HYDROLOGICAL ANALYSIS AND FORECASTING

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY		
COURSE TITLE: HYDROLOGICAL ANALYSIS AND FORECASTING	COURSE CODE: HWR 222	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 enable students to have knowledge of hydrological analysis, prediction and forecasting		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand uses of models; 2.0 Understand types of model; 3.0 Understand simulation of river basins; 4.0 Understand the use of statistics in forecasting; 5.0 Understand the use of GIS in hydrological modelling; 6.0 Understand ungauged basins; 7.0 Understand rainfall forecasting.		

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY						
COURSE TITLE: HYDROLOGICAL ANALYSIS AND FORECASTING			COURSE CODE: HWR 222		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 enable students to have knowledge of hydrological analysis, prediction and forecasting						
General Objectives 1.0: Understand uses of models						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-2	1.1 Define hydrological models and hydrological forecasting. 1.2 Explain the use of models in hydrology and water resource 1.3 Identify the role of forecasting in hydrology	• Explain hydrological models and hydrological forecasting. • Discuss the use of models in hydrology and water resource • Explain the role of forecasting in hydrology	White board, Marker, duster, Laptop, video, overhead projector, Hydrological softwares, Statistical softwares			
General Objectives 2.0: Understand types of model						
3-4	2.1 Describe different types of models used in environmental, hydrological, and	• Explain different types of models used in environmental, hydrological, and	White board, Marker, duster, Laptop, video, overhead projector,	• Identify the different types of models used in environmental and hydrological	• Identify the different types of models used in environmental and hydrological studies. • Classify models based	Charts, diagrams, model samples. Classification charts,

	meteorological studies. 2.2 Distinguish between physical, conceptual, mathematical, deterministic, stochastic, empirical, and simulation models. 2.3 Classify models based on their characteristics and applications. 2.4 Explain the use of simple models to represent real-world environmental systems. 2.5 Explain model outputs and their practical applications in solving environmental problems.	meteorological studies. • Distinguish between physical, conceptual, mathematical, deterministic, stochastic, empirical, and simulation models. • Explain models based on their characteristics and applications. • Explain the use of simple models to represent real-world environmental systems. • Explain model outputs and their practical applications in solving environmental problems.	Hydrological softwares, Statistical softwares	studies. • Classify models based on their characteristics and applications. • Construct a simple conceptual or physical model. • Interpret the outputs and applications of different models.	on their characteristics and applications. • Construct a simple conceptual or physical model. • Interpret the outputs and applications of different models.	worksheets. Cardboard, markers, model materials, laboratory manual. Computer, projector, modelling software (e.g., Excel or HEC-HMS).
General Objectives 3.0: Understand simulation of river basins						
5-6	3.1 Discuss purpose of runoff simulation hydrological simulation of river	• Discuss purpose of runoff simulation hydrological simulation of river	Lecture note, White board, Marker, duster, Laptop, video,	• Carry out simulation of rivers basins • Use Hydrological data in Runoff	Guide students to: • Carry out simulation of rivers basins • Use Hydrological data	SWAT, QGIS, HEC-SMS, HEC-RAS etc.

	basins 3.2 Explain the place of hydrological data in runoff simulation 3.3 Classify hydrological models: stochastic and process based models	basins • Explain the place of hydrological data in runoff simulation • Explain hydrological models: stochastic and process based models	overhead projector, Software	simulation	in Runoff simulation	
General Objectives 4.0: Understand the use of statistics in forecasting						
7-8	4.1 Explain the role of statistics in hydrological modelling and statistics 4.2 Discuss the use of running mean, trend analysis in elementary prediction. 4.3 Explain time series characteristics of Hydrological events- cycles, periodicities', seasonality and persistence 4.4 Explain the role Probability theory in modelling –	• Explain the role of statistics in hydrological modelling and statistics • Discuss the use of running mean, trend analysis in elementary prediction. • Explain time series characteristics of Hydrological events- cycles, periodicities', seasonality and persistence • Explain the role Probability theory in	Lecture note, White board, Marker, duster, Laptop, video, overhead projector, Statistical Softwares, SPSS, ArcGIS, SAS	• Demonstrate the operations of the softwares using simple and less complex scenarios • Analyse statistics in hydrological modeling • Perform trend analysis in elementary prediction • Identify time series characteristics of hydrological events.	Guide students to: • Demonstrate the operations of the softwares using simple and less complex scenarios • Analyse statistics in hydrological modeling • Perform trend analysis in elementary prediction • Identify time series characteristics of hydrological events.	Any available hydrological data such as Rainfall data, Temperature data etc.

	Poisson Distribution.	modelling – Poisson Distribution.				
General Objectives 5.0: Understand the use of GIS in hydrological modelling						
9-10	5.1 Explain the concept of GIS and its role in hydrological modelling. 5.2 Describe the spatial data used in GIS for hydrological modelling. 5.3 Explain the applications of GIS in hydrological modelling. 5.4 Describe the advantages and limitations of GIS in hydrological modelling.	• Explain the concept of GIS and its role in hydrological modelling. • Discuss the spatial data used in GIS for hydrological modelling. • Explain the applications of GIS in hydrological modelling. • Explain the advantages and limitations of GIS in hydrological modelling.	Lecture note, White board, Marker, duster, Laptop, video, overhead projector,	• Identify the role of GIS in hydrological modelling. • Demonstrate basic GIS operations for hydrological analysis. • Analyse hydrological features using GIS tools. • Interpret GIS outputs for hydrological modelling.	Guide students to: • Identify the role of GIS in hydrological modelling. • Demonstrate basic GIS operations for hydrological analysis. • Analyse hydrological features using GIS tools. • Interpret GIS outputs for hydrological modelling.	GIS maps, computer, projector. Computer, QGIS/ArcGIS software, DEM data. GIS software, spatial datasets, worksheets. GIS-generated maps, laboratory manual.
General Objectives 6.0: Understand ungauged basins						
11-12	6.1 Explain the concept of ungauged basins. 6.2 Describe the methods used to assess ungauged basins. 6.3 Explain the challenges associated with ungauged basins.	• Explain the concept of ungauged basins. • Discuss the methods used to assess ungauged basins. • Explain the challenges associated with ungauged basins.	White board, Marker, duster, Laptop, video, overhead projector,	• Identify the characteristics of an ungauged basin. • Delineate an ungauged watershed using GIS tools. • Estimate hydrological	Guide students to: • Identify the characteristics of an ungauged basin. • Delineate an ungauged watershed using GIS tools. • Estimate hydrological	Topographic maps, satellite images, GIS software. Computer, QGIS/ArcGIS, DEM data. Hydrological data, calculator, GIS software,

	6.4 Explain the applications of ungauged basin studies in water resources management.	Explain the applications of ungauged basin studies in water resources management.		parameters of an ungauged basin. Interpret results from ungauged basin analysis.	parameters of an ungauged basin. Interpret results from ungauged basin analysis.	worksheets. Projector, laboratory manual, case study datasets.
General Objectives 7.0: Understand rainfall forecasting						
13-15	7.1.Explain the methods of rainfall forecasting-rank correlation, Mann Kendal statistics. 7.2.Explain the methods of drought forecasting-SPI, Rainfall anomaly index 7.3.Explain the methods of flood forecasting-Gumbel analysis	- Explain the methods of rainfall forecasting-rank correlation, Mann Kendal statistics. - Explain the methods of drought forecasting-SPI, Rainfall anomaly index - Explain the methods of flood forecasting-Gumbel analysis	White board, Marker, duster, Laptop, video, overhead projector,	Demonstrate using Statistical packages at prediction low flow and peak flow using simple examples	Illustrate and solve some simple examples by forming the student into study groups and give tasks	SWAT, ArcGIS, STATGRAPH
COURSE ASSESSMENT: Course work 10% Test/Assignments 10% Practical 40% Examination 40% = 100%						

WATER SUPPLY AND WASTE TECHNOLOGY

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY		
COURSE TITLE: WATER SUPPLY AND WASTE TECHNOLOGY	COURSE CODE: HWR 223	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 to equip students with knowledge and skill of plan water supply and design a wastewater treatment setup.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Know how to estimate water demand; 2.0 Know sources of water; 3.0 Know the principles of intake design; 4.0 Know the different types of pump and their selection; 5.0 Understand the basic water treatment processes; 6.0 Understand methods of storage and distribution of treated water; 7.0 Know the general principles involved in rural water supply; 8.0 Know the sources and characteristics of waste water; 9.0 Understand basic methods and processes of sewage treatment; 10.0 Know Major Sewer Appurtenances; 11.0 Understand the Effects of Wastewater Pollution and Methods of Control.		

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY						
COURSE TITLE: WATER SUPPLY AND WASTE TECHNOLOGY			COURSE CODE: HWR 223		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 to equip students with knowledge and skill of plan water supply and design a wastewater treatment setup.						
General Objective 1.0: Know How to Estimate Water Demand						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1	1.1 Define water demand and water consumption. 1.2 Explain the categories of water demand. 1.3 Explain factors affecting water demand. 1.4 Calculate average daily demand, maximum daily demand and peak demand. 1.5 Explain population forecasting methods	• Explain concepts of water demand and factors affecting consumption. • Discuss the categories of water demand. • Explain factors affecting water demand. • Calculate average daily demand, maximum daily demand and peak demand. • Explain population forecasting methods	Whiteboard, textbooks, Water supply manuals. Charts, case studies. Calculators, worksheets. Population data records	• Estimate present and future population. • Compute water demand for a community. • Determine peak factors and design demand. • Prepare water demand reports.	Guide students to: • Population projection exercises. • Compute water demand for a community. • Determine peak factors and design demand. • Prepare water demand reports.	Census data, calculators. Worksheets. Design manuals. Report templates
General Objective 2.0: : Know Sources of Water						

2	2.1 Define water sources. 2.2 Describe characteristics of water sources. 2.3 Explain advantages and disadvantages of various water sources. 2.4 Describe source protection measures	• Discuss water sources. • Explain characteristics of water sources. • Explain advantages and disadvantages of various water sources. • Explain source protection measures	Charts, textbooks. Water quality manuals. Multimedia presentations. Environmental guidelines	• Identify water sources in the locality. • Prepare source inventory reports. • Assess source characteristics • Record and report findings	Guide students to: • Identify water sources in the locality. • Prepare source inventory reports. • Assess source characteristics. • Record and report findings	Maps, GPS. Water testing kits. Field notebooks
General Objective 3.0: Know the Principles of Intake Design						
3	3.1 Define water intake structures. 3.2 Describe types of intake structures. 3.3 Explain factors influencing intake design. 3.4 Explain intake components.	• Explain functions and importance of intake systems. • Discuss river, lake, reservoir and canal intakes. • Discuss water level variation, sediment load and flow conditions. • Explain screens, gates, valves and approach channels	Charts, textbooks. Models, diagrams. Design manuals. Engineering drawings	• Identify intake components. • Prepare simple intake designs. • Inspect intake structures • During field trip • Report findings	Guide students to: • Demonstrate intake structure models. • Guide design exercises. • Organize field visits. • Record and report findings	Models, diagrams. Drawing instruments. Existing waterworks
General Objective 4.0: Know the Different Types of Pumps and Their Selection						
4	4.1 Define pumps and pumping systems. 4.2 Describe different pump types.	• Explain pump functions in water supply. • Discuss centrifugal,	Textbooks, charts. Pump catalogues.	• Identify pump components. • Operate different pumps.	Guide students to: • Identify pump components. • Operate different	Pump models. Laboratory pumps. Measuring

	4.3 Explain pump characteristics. 4.4 Describe criteria for pump selection	reciprocating, turbine and submersible pumps. • Discuss discharge, head and efficiency. • Explain factors affecting pump choice	Pump performance curves. Design manuals	• Determine pump efficiency. • Select suitable pumps for specific applications • Report findings	pumps. • Determine pump efficiency. • Select suitable pumps for specific applications. • Record and report findings	instruments. Manufacturer catalogues
General Objective 5.0: Understand the Basic Water Treatment Processes						
5	5.1 Define water treatment. 5.2 Describe treatment processes. 5.3 Explain treatment plant layout. 5.4 Discuss water quality standards	• Explain water treatment. • Discuss treatment processes. • Explain treatment plant layout. • Discuss water quality standards	Treatment manuals. Process flow charts. Plant diagrams. WHO guidelines	• Conduct jar test experiments. • Measure treatment efficiency. • Operate filtration units. • Apply disinfection methods • Report findings	Guide students to: • Conduct jar test experiments. • Measure treatment efficiency. • Operate filtration units. • Apply disinfection methods. • Record and report findings	Jar test apparatus. Water testing kits. Sand filters. Chlorine test kits
General Objective 6.0: Understand Methods of Storage and Distribution of Treated Water						
6	6.1 Define water storage and distribution systems. 6.2 Explain storage facilities. 6.3 Explain distribution systems. 6.4 Describe	• Explain purposes and functions. • Discuss reservoirs, tanks and elevated storage structures. • Discuss gravity, pumping and combined systems.	Textbooks. Models, diagrams. Network diagrams. Engineering drawings	• Identify distribution components. • Prepare simple distribution layouts. • Measure storage tank capacity. • Inspect water distribution systems	Guide students to: • Identify distribution components. • Prepare simple distribution layouts. • Measure storage tank capacity. • Inspect water	Pipe fittings. Drawing instruments. Measuring tapes. Water supply schemes

	distribution components	• Explain pipes, valves, hydrants and meters		• During field trips • Report findings	distribution systems. • Record and report findings	
General Objective 7.0: Know the General Principles Involved in Rural Water Supply						
7-8	7.1. Define rural water supply. 7.2. Identify rural water supply technologies. 7.3. Explain community participation. 7.4. Describe operation and maintenance requirements	• Explain objectives and importance. • Discuss boreholes, hand pumps, wells and rainwater harvesting. • Discuss management and sustainability issues. • Explain maintenance procedures	Rural water manuals. Charts. Case studies. O&M manuals	• Inspect rural water facilities. • Demonstrate hand pump maintenance. • Assess community water needs. • Prepare rural water supply plans • Field trips • Report findings	Guide students to: • Inspect rural water facilities. • Demonstrate hand pump maintenance. • Assess community water needs. • Prepare rural water supply plans	Boreholes, wells. Hand pump assembly. Questionnaires. Planning templates
GENERAL OBJECTIVE 8.0: Know the Sources and Characteristics of Wastewater						
9-10	8.1 Define wastewater. 8.2 Explain sources of wastewater. 8.3 Describe physical, chemical and biological characteristics. 8.4 Describe environmental impacts of wastewater	• Explain wastewater generation and composition. • Discuss domestic, industrial and storm water sources. • Explain wastewater quality parameters. • Explain pollution effects	Textbooks. Charts. Laboratory manuals. Case studies	• Collect wastewater samples. • Measure wastewater characteristics. • Analyze wastewater data • Record and report findings	Guide students to: • Collect wastewater samples. • Measure wastewater characteristics. • Analyze wastewater data. • Record and report findings	Sampling bottles. Water quality equipment. Laboratory reports
GENERAL OBJECTIVE 9.0: Understand Basic Methods and Processes of Sewage Treatment						

11-12	9.1. Define sewage treatment. 9.2. Describe treatment stages. 9.3. Explain biological treatment processes. 9.4. Explain sludge treatment methods	• Explain treatment objectives. • Discuss preliminary, primary, secondary and tertiary treatment. • Discuss activated sludge, trickling filters and oxidation ponds. • Discuss digestion and dewatering	Treatment manuals. Flow diagrams. Charts. Plant manuals	• Observe sewage treatment processes. • Analyze treatment performance. • Demonstrate sludge handling methods • During field trips • Report findings	Guide students to: • Observe sewage treatment processes. • Analyze treatment performance. • Demonstrate sludge handling methods. • Record and report findings	Treatment plants. Testing equipment. Sludge processing equipment
GENERAL OBJECTIVE 10.0: Know Major Sewer Appurtenances						
13-14	10.1. Define sewer appurtenances. 10.2. Explain sewer appurtenances. 10.3. Explain design considerations. 10.4. Describe maintenance requirements	• Discuss sewer appurtenances Explain functions and importance. • Discuss manholes, cleanouts, lamp holes, flushing tanks and catch basins. • Explain placement and spacing requirements. • Explain inspection and cleaning procedures	Textbooks. Charts. Engineering drawings. Maintenance manuals	• Identify sewer appurtenances in the field. • Measure dimensions of appurtenances. • Prepare simple sewer layouts • Report findings	Guide students to: • Identify sewer appurtenances in the field. • Measure dimensions of appurtenances. • Prepare simple sewer layouts. • Record and report findings	Sewer systems. Measuring tools. Drawing materials
GENERAL OBJECTIVE 11.0: Understand the Effects of Wastewater Pollution and Methods of Control						

15	11.1 Define environmental pollution of wastewater 11.2 Describe effects of wastewater pollution. 11.3 Explain wastewater pollution prevention measures. 11.4 Describe wastewater pollution control technologies	• Explain types and sources pollution of wastewater • Discuss health, economic and ecological impacts. • Discuss source control and waste minimization. • Explain wastewater treatment and environmental management systems	Textbooks. Case studies. Environmental regulations. Pollution control manuals	• Identify wastewater pollution sources. • Monitor wastewater pollution indicators. • Evaluate wastewater pollution control measures. • Prepare wastewater pollution assessment reports	Guide students to: • Identify wastewater pollution sources. • Monitor wastewater pollution indicators. • Evaluate wastewater pollution control measures. • Prepare wastewater pollution assessment reports	Inspection checklists. Water testing kits. Environmental reports. Templates
COURSE ASSESSMENT: Course work 10% Test/Assignments 10% Practical 40% Examination 40% = 100%						

DIGITAL WATER MONITORING SYSTEMS

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY		
COURSE TITLE: DIGITAL WATER MONITORING SYSTEMS	COURSE CODE: HWR 224	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 skill of competencies needed to deploy, operate, and maintain modern digital water monitoring systems.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Select appropriate digital sensors for monitoring water level, flow, pressure, and water quality parameters; 2.0 Configure data acquisition systems for real-time environmental monitoring; 3.0 Design and implement basic IoT-enabled water monitoring networks; 4.0 Analyse digital monitoring datasets to identify trends, anomalies, and operational issues; 5.0 Integrate sensor data with GIS and cloud-based platforms for decision-making; 6.0 Develop simple automated alert systems for flood, drought, and water quality monitoring.		

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY						
COURSE TITLE: DIGITAL WATER MONITORING SYSTEMS			COURSE CODE: HWR 224		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 skill of competencies needed to deploy, operate, and maintain modern digital water monitoring systems.						
General Objective 1.0: Select appropriate digital sensors for monitoring water level, flow, pressure, and water quality parameters.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-2	1.1 Define digital water monitoring systems. 1.2 Explain the principles and concepts of digital water monitoring systems. 1.3 Enumerate the various digital monitoring sensors.	• Explain digital water monitoring systems. • Explain the principles and concepts of digital water monitoring systems. • Enumerate the various digital monitoring sensors.	Laptop Computers, Smart board, White board, Projector, Marker, duster, Internet	• Install, configure, and operate digital water level instruments and sensors. • Install, configure, and operate digital pressure sensors. • Install, configure, and operate digital flow sensors.	Guide students to: • Install, configure, and operate digital water level instruments and sensors. • Install, configure, and operate digital pressure sensors. • Install, configure, and operate digital flow sensors.	Laptop, Laboratory Equipment, Instruments, Writing materials, Projector
General Objective 2.0: Configure data acquisition systems for real-time environmental monitoring						
3-5	2.1 Explain brief history of sensors, data loggers,	• Discuss brief history of sensors, data loggers, telemetry,	Computers, Smart board, White board,	• Understanding error reading from Digital monitoring	Guide students to: • Understanding error reading from Digital	Laboratory Equipment, Instruments,

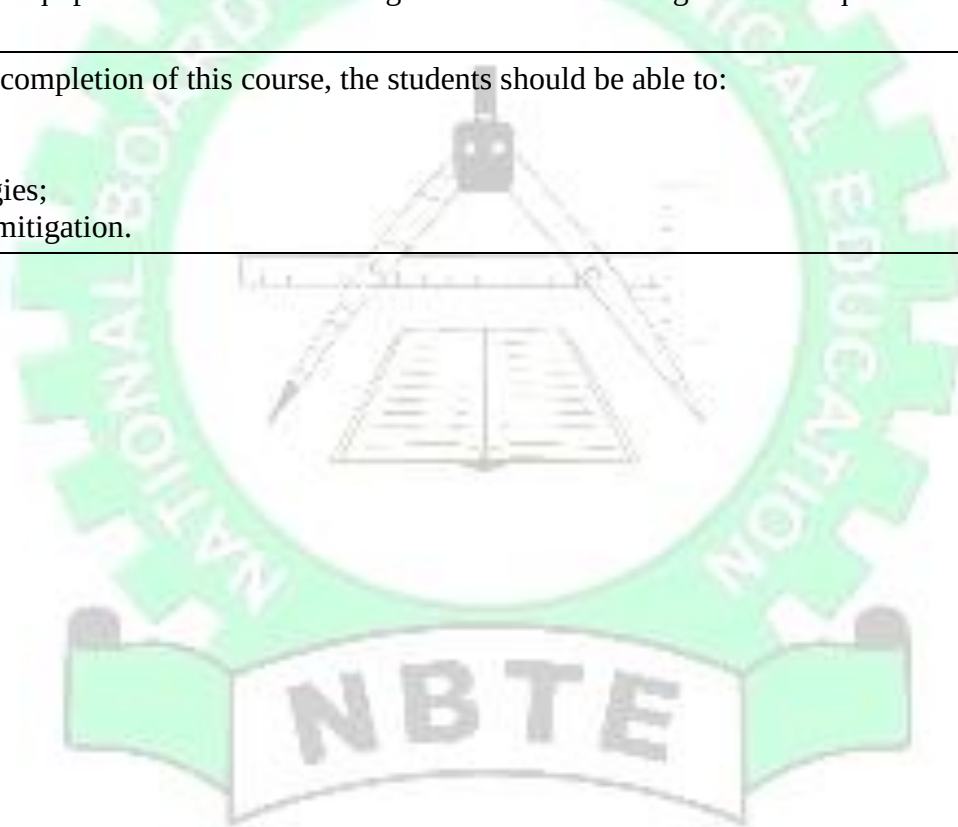
	telemetry, and communication networks in water monitoring. 2.2 Explain the relevance of Digital monitoring devices 2.3 Explain factors that affect reading of Digital monitoring devices.	and communication networks in water monitoring. • Explain the relevance of Digital monitoring devices • Explain factors that affect reading of Digital monitoring devices.	Projector, Marker, duster, Internet	devices. • Calibrate and validate monitoring equipment to ensure data accuracy and reliability. • Techniques for handling water monitoring devices.	monitoring devices. • Calibrate and validate monitoring equipment to ensure data accuracy and reliability. • Techniques for handling water monitoring devices.	Writing materials, Projector
General Objective 3.0: Design and implement basic IoT-enabled water monitoring networks						
6-8	3.1 Explain the operation of Internet of Things (IoT) technologies in water resources management 3.2 Explain the applications of Internet of Things (IoT) technologies in water resources management 3.3 Describe Internet of Things (IoT) technologies in water resources management	• Explain the operation of Internet of Things (IoT) technologies in water resources management • Explain the applications of Internet of Things (IoT) technologies in water resources management • Explain Internet of Things (IoT) technologies in water resources management	Computers, Smart board, White board, Projector, Marker, duster, Internet	• Develop basic IoT-based water monitoring systems. • Deploy basic IoT-based water monitoring systems • Calibrate and validate basic IoT-based water monitoring systems	Guide students to: • Develop basic IoT-based water monitoring systems. • Deploy basic IoT-based water monitoring systems • Calibrate and validate basic IoT-based water monitoring systems	Laboratory Equipment, Instruments, Writing materials, Projector
General Objective 4.0: Analyse digital monitoring datasets to identify trends, anomalies, and operational issues.						

9-11	4.1 Discuss methods for monitoring water quantity and digital technologies 4.2 Explain methods for monitoring water quality parameters using digital technologies 4.3 Describe the procedure to analyse digital monitoring devices	• Discuss methods for monitoring water quantity and digital technologies • Explain methods for monitoring water quality parameters using digital technologies • Explain the procedure to analyse digital monitoring devices	Computers, Smart board, White board, Projector, Marker, duster, Internet	• Interpret datasets from the analysis of digital monitoring devices. • Identify trends and anomalies from Results. • How to handle operational issues	Guide students to: • Interpret datasets from the analysis of digital monitoring devices. • Identify trends and anomalies from Results. • How to handle operational issues	Laboratory Equipment, Instruments, Writing materials, Projector
General Objective 5.0: Integrate sensor data with GIS and cloud-based platforms for decision-making.						
12-13	5.1 Explain the term integrated sensor data. 5.2 Describe cloud-based platform for decision making. 5.3 Explain the principles of real-time data acquisition, transmission, storage, and visualization	• Explain the term integrated sensor data. • Explain cloud-based platform for decision making. • Explain the principles of real-time data acquisition, transmission, storage, and visualization	Computers, Smart board, White board, Projector, Marker, duster, Internet	• Utilize telemetry systems for remote monitoring of water resources • Utilize pressure sensors systems for remote monitoring of water resources • Utilize flow sensor for remote monitoring of water resources	• Utilize telemetry systems for remote monitoring of water resources • Utilize pressure sensors systems for remote monitoring of water resources • Utilize flow sensor for remote monitoring of water resources	Laboratory Equipment, Instruments, Writing materials, Projector
General Objective 6.0: Develop simple automated alert systems for flood, drought, and water quality monitoring.						
14-15	6.1 Define simple automated alert	• Explain simple automated alert	Computers, Smart board,	• Design simple automated alert	Guide students to: • Design simple	Laboratory Equipment,

	systems for water monitoring. 6.2 Explain early warning alert system for flood. 6.3 Explain early warning alert system for water quality monitoring.	systems for water monitoring. • Discuss early warning alert system for flood. • Discuss early warning alert system for water quality monitoring.	White board, Projector, Marker, duster, Internet	systems for water monitoring of flood using appropriate software tools • Design simple automated alert systems for water quality monitoring. • Simulate draught using digital monitoring data and appropriate software tools	automated alert systems for water monitoring of flood using appropriate software tools • Design simple automated alert systems for water quality monitoring. • Simulate draught using digital monitoring data and appropriate software tools	Instruments, Writing materials, Projector
COURSE ASSESSMENT: Course work 10% Test/Assignments 10% Practical 40% Examination 40% = 100%						

SMART CLIMATE VARIABILITY ANS WATER IMPACT

PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY		
COURSE TITLE: SMART CLIMATE VARIABILITY ANS WATER IMPACT	COURSE CODE: HWR 225	CONTACT HOURS: 3 HOURS/WEEK
	CREDIT UNIT: 3	THEORETICAL: 1 HOUR/WEEK
YEAR: II SEMESTER: II	PRE-REQUISITE:	PRACTICAL: 2 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills and on digital tools required to understand climate variability and its impact on water resources.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand climate systems; 2.0 Understand climate risks; 3.0 Understand adaptation strategies; 4.0 Understand Advance climate mitigation.		



PROGRAMME: NATIONAL DIPLOMA IN HYDROLOGY AND WATER RESOURCES MANAGEMENT TECHNOLOGY						
COURSE TITLE: SMART CLIMATE VARIABILITY AND WATER IMPACT			COURSE CODE: HWR 225		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: This course is designed to equip students with knowledge and skills and on digital tools required to understand climate variability and its impact on water resources.						
GENERAL OBJECTIVE 1.0: Understand Climate Systems						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-4	1.1 Define the major components of the climate system 1.2 Explain how they interact 1.1. 1.3 Explain the Earth’s energy balance. 1.4 Evaluate their role in regulating global temperatures1.3. 1.5 Explain global atmospheric circulation patterns (Hadley, Ferrel, and Polar cells) and their influence on weather and climate zone	• Explain the major components of the climate system • Explain how they interact 1.1. • Explain the Earth’s energy balance, • Evaluate their role in regulating global temperatures1.3. • Explain global atmospheric circulation patterns (Hadley, Ferrel, and Polar cells) and their influence on weather and climate zone	Computer Charts Multimedia Resources, Marker, Projector	• Demonstrate albedo and greenhouse effects using simple materials such as lamps, thermometers, mirrors, colored surfaces to, visualize Earth’s energy balance • Report findings	Guide students to: • Carry out Albedo and greenhouse effects using simple materials such as lamps, thermometers, mirrors, colored surfaces to, visualize Earth’s energy balance • Record and report findings	Simple lab materials lamps, thermometers, mirrors, colored surfaces Videos clips

	1.6 Discuss how human activities affect climate systems and evaluate strategies for mitigation and adaptation	• Discuss how human activities affect climate systems and evaluate strategies for mitigation and adaptation				
General Objective 2.0: Understand Climate Risks						
5-8	2.1 Explain different types of climate risks (physical, social, economic, ecological) and categorize them according to severity and likelihood. 2.2 Discuss climate hazards such as floods, droughts, heatwaves, and storms, and explain their causes and potential impacts. 2.3 Discuss the vulnerability of communities, ecosystems, and infrastructure to climate risks, considering social, economic, and geographic location	• Explain types of climate risks (physical, social, economic, ecological) and categorize them according to severity and likelihood. • Discuss climate hazards such as floods, droughts, heatwaves, and storms, and explain their causes and potential impacts. • Discuss the vulnerability of communities, ecosystems, and infrastructure to climate risks, considering social, economic, and geographic location	Computer Charts Multimedia Resources, Marker, Projector	• Carry out group activities to map areas in their community vulnerable to flooding, erosion, or heatwaves, then present adaptation ideas. • Design practical interventions (e.g., disaster preparedness plans, resilient infrastructure, sustainable for farming practices) • Report findings	Guide students to: • Carry out Students to map areas in their community vulnerable to flooding, erosion, or heatwaves, then present adaptation ideas. • Design practical interventions (e.g., disaster preparedness plans, resilient infrastructure, sustainable for farming practices) • Record and report findings	Computer Ready-made charts, graphs, and datasets. Multimedia resources such as videos, infographics, and podcasts

General Objective 3.0: Understand Adaptation Strategies						
9-12	3.1 Define climate adaptation and distinguish it from mitigation, resilience, and disaster response. 3.2 Describe the specific vulnerabilities of communities, ecosystems, and infrastructure to determine where adaptation is most urgently required 3.3 Explain Adaptation Options such as flood defenses, drought-resistant crops, urban cooling systems, and coastal protection, analyzing their effectiveness and feasibility. 3.4 Describe Local Adaptation Plans that integrate scientific data, local knowledge, and	• Explain climate adaptation and distinguish it from mitigation, resilience, and disaster response • Discuss the specific vulnerabilities of communities, ecosystems, and infrastructure to determine where adaptation is most urgently required • Discuss Adaptation Options such as flood defenses, drought-resistant crops, or urban cooling systems, analyzing their effectiveness and feasibility. • Explain Local Adaptation Plans that integrate scientific data, local knowledge, and socio-economic considerations. • Explain	Computer Charts Multimedia Resources, Marker, Projector	• Demonstrate understanding of cultural, linguistic, and ability differences that require curriculum adaptation. • Report findings	Guide students to: • Present real or simulated classroom scenarios (e.g., a mixed-ability group, multilingual learners) • Record and report findings	Screen readers, text-to-speech apps, translation software. Simulation kits

	socio-economic considerations. 3.5 Explain communication skills to advocate for adaptation strategies in policy discussions, media, and community forums.	communication skills to advocate for adaptation strategies in policy discussions, media, and community forums.				
General Objective 4.0: Understand Advance Climate Mitigation						
13-15	4.1 Define climate science, including greenhouse gas dynamics, carbon cycles, and feedback mechanisms. 4.2 Explain the role of anthropogenic activities in accelerating climate change using quantitative models. 4.3 Discuss cost-benefit analyses of mitigation strategies across sectors.	• Explain climate science, including greenhouse gas dynamics, carbon cycles, and feedback mechanisms • Discuss the role of anthropogenic activities in accelerating climate change using quantitative models • Explain cost-benefit analyses of mitigation strategies across sectors.	Intergovernmental Panel on Climate Change (IPCC) Reports UN Sustainable Development Goals SDGs Document	• Design awareness campaigns that promote climate-friendly behavior (e.g., tree planting, waste-to-energy initiatives). • Measure the classroom's energy use, waste generation, and transportation habits • Report findings	Guide students to: • Design awareness campaigns that promote climate-friendly behavior (e.g., tree planting, waste-to-energy initiatives). • Measure the classroom's energy use, waste generation, and transportation habits • Record and report findings	Banner Loud speaker Marker

COURSE ASSESSMENT:

Course work 10%

Test/Assignments 10%

Practical 40%

Examination 40% = 100%



LIST OF MINIMUM RESOURCES/PHYSICAL FACILITIES**LIST OF LABORATORIES****1. FLUID MECHANICS/HYDRAULICS/HYDROLOGY**

S/N	DESCRIPTION OF ITEMS	QUANTITY
1.	Anemometer Evaporation pan	1
2.	Current meters (Global Water) Rain gauges	1
3.	Water tank Barometer, Piezometer Hydrometer	1
4.	Surge tank demonstration set Pitot tube	1
5.	Float (hydrometry) Stop watches Measuring tapes	1
6.	Meteorological station (with equipment) Rain fall simulator	1
7.	Water Hammer apparatus Drying ovens	1
8.	Balances e.g. analytical balance triple beam Thermometers	1
9.	Measuring cylinders Soil hydrometers	5
10.	Crucibles, spatulas, funnels Desiccators	5
11.	Stop watches Glass wares	1
12.	Porcelain mortar & Pistle Mallet	1
13.	Specific gravity test apparatus	2
14.	Lysimeter	2 set
15.	Disdrometer	2
16.	Anemometer Evaporation pan	3
17.	Current meters (Global Water) Rain gauges	3
18.	Windvane and Anemometer	3
19.	Density test apparatus	3
20.	Hygrometer	5 of each
21.	Resistivity Meter	1
22.	Software for Groundwater Investigation Analysis (MODFLOW, FEFLOWGMS, AquaChem, PHREEQC, KISTER etc.	5
23.	Terrameter	3
24.	Sunshine Recorder	3
25.	Water Quality measurement kit	

26.	Flow meters	
27.	Infiltrometer	
28.	All the different types of map- Topomaps, thematic maps etc.	
29.	Groundwater charts	1
30.	Current meter	1
31.	Projector	1
EQUIPMENTS DRILLING BOREHOLE		
32.	Drilling bit	1
33.	Drill pipes	1
34.	Drill clamp	1
35.	Mud pump generator	1
36.	Digger	10
37.	Shovels	2
38.	Range	

2. LIST OF STUDIO/DRAWING ROOM

STUDIO/DRAWING ROOM (For ND/ HND)

S/N	DESCRIPTION OF ITEMS	QUANTITY
1.	Drawing table	40
2.	T-Square	40
3.	Set square	3
4.	Drawing pen	3
5.	Chalkboard set square	4 sets
6.	Chalkboard protractors	2
7.	Chalkboard divider	2
8.	Chalkboard pair of compasses	2
9.	Chalkboard wooden straight edges	2
10.	Chalkboard lettering set	2 sets
11.	Templates	2 sets
12.	Plastic curves	2 sets

13.	French curves (metric) set	2 sets
14.	Projector	1
15.	Engineering scale rules	Assorted 10 each

3. SURVEYING EQUIPMENT STORE

S/N	DESCRIPTION OF ITEMS	QUANTITY
1.	Compasses with tripods	3
2.	Mirror Stereoscope (HND)	3
3.	Staves	5
4.	Ranging Poles	20
5.	Surveying Umbrella	6
6.	Chains	5
7.	Steel arrows	15
8.	Planimeters	3
9.	Tapes(30m, 50m, 100m)	4
10.	Optical square	3
11.	Pocket altimeter	2
12.	Steel band Differential GPS	3
13.	Steel arrows	15

4. COMPUTER AND GIS LABORATORY

S/N	Description	QUANTITY
1	Hard wares	5
2	Pentium Base Computers	2
3	9 Second Total Station and Accessories	1 pair
4	Handheld GPS (HND)	1
5	EDM (HND)	1
6	Digital Theodolite	1
SOFTWARE		
7	DBMS	3

8	SURFER-S	1
9	MAPMAKERS	1
10	Spreadsheet	1
11	Word-processing	1
12	ARCVIEW/ARCINFO/MAPINFO,ARC MAP	1
13	HEC-RAS, HEC-HMS, SWMM, QGIS, SWAT	1

5. SAFETY EQUIPMENT (For each Workshop)

S/N	DESCRIPTIONS	QUANTITY
1	First aid box	1
2	Safety goggles	32
3	Safety helmet	32
4	Rubber boots	32 pairs

LIST OF PARTICIPANTS

S/N	NAME	ADDRESS	EMAIL
1.	Prof. Idris M. Bugaje	Executive Secretary, National Board for Technical Education, Kaduna	es@nbte.gov.ng
2.	Prof. Abubakar Ismail	Dept. of Water Res. and Env. Engineering A.B.U, Zaria	aismail@gabu.edu.ng
3.	Dr. Rufai Ibrahim	College of Agriculture and Animal Science Mando	rufai37@yahoo.co.uk
4.	Engr. Farida Ujudud Shariff	Department of Water Resources Engineering Technology National Water Resources Institute, Mando, Kaduna	fareedah456@gmail.com
5.	Salami I. Adedotun	Dept of Hydrology and Water Resources Management National Water Resources Institute Mando Kaduna	adedotun.salami@gmail.com
6.	Dr. Ugochi Elizabeth Okoronkwo	Federal College of Fisheries and Marine Technology Victoria Island, Lagos	okoronkwoelizabeth@yahoo.com
7.	Engr. Rowland Ahiome	Sector Skill Council for Agriculture	rowlandahiome@gmail.com
8.	Dr. O.O. Bello	Director (Curriculum Development) National Board for Technical Education, Kaduna.	engroobello@gmail.com
9.	Mr. Ayo Aroge	Director (Polytechnic and Allied Programmes) National Board for Technical Education, Kaduna.	ayoaroge2@gmail.com
10.	Dr. Kubura Jauro D.	Deputy Director (Agric Technology Division) National Board for Technical Education, Kaduna	kuburagombe@yahoo.com
11.	Nsan Tiku Nsan	National Board for Technical Education, Kaduna	santodaape2@gmail.com
12.	Abdulrahman Idris	National Board for Technical Education, Kaduna	Idrisabdulraham12@gmail.com
13.	Jamila Jibrin	National Board for Technical Education, Kaduna	jibrinjamila@gmail.com
14.	Usman Sabo	National Board for Technical Education, Kaduna	Usmansabo42@gmail.com