



NATIONAL BOARD FOR TECHNICAL EDUCATION

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

NATIONAL DIPLOMA

IRRIGATION AGRONOMY TECHNOLOGY

CURRICULUM AND COURSE SPECIFICATIONS

JUNE, 2026

PREFACE

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

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

Professor Idris M. Bugaje, FNSE
Chairman, Implementation Committee
EXECUTIVE SECRETARY
National Board for Technical Education (NBTE), Kaduna

ACKNOWLEDGEMENT

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

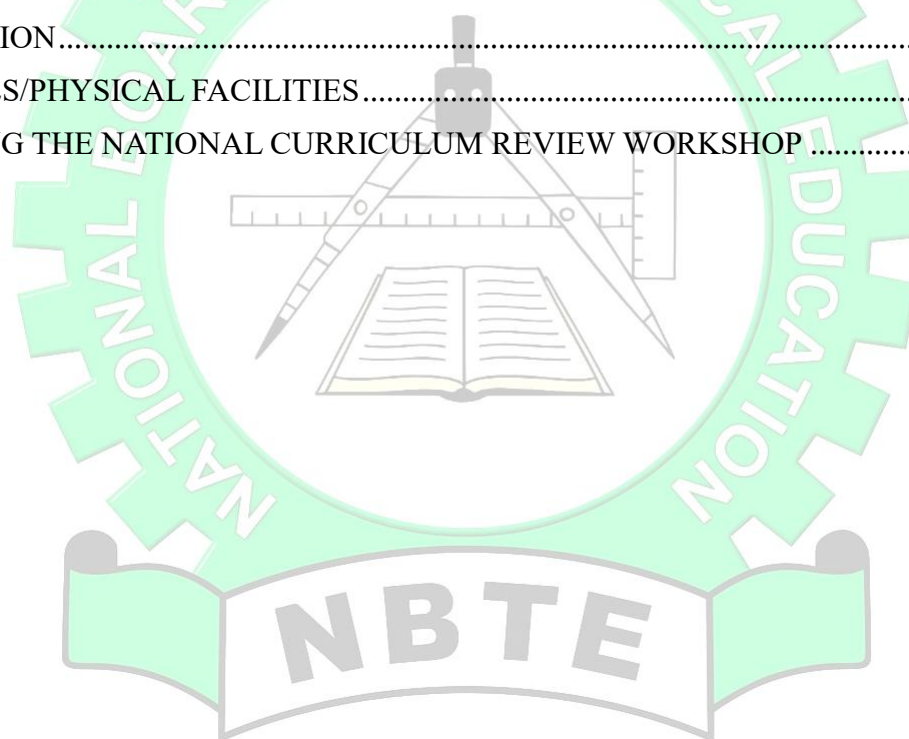
Special appreciation is extended to the members of the agriculture, curriculum specialists, resource persons, academic experts, professional bodies, regulatory agencies, employers, industry practitioners, development partners, and representatives of public and private sector organizations who participated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



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GENERAL INFORMATION

1.0 PROGRAMME NOMENCLATURE

National Diploma (ND) in Irrigation Agronomy Technology.

2.0 PROGRAMME GOAL

The National Diploma in Irrigation Agronomy Technology prepares diplomates as technicians to manage modern irrigation systems, support sustainable and climate-smart crop production, and participate in irrigation agribusiness and water resource management in line with global best practices for Irrigation Systems.

3.0 OBJECTIVES OF THE PROGRAMME

On completion of the programme, the diplomates should be able to:

- i. Assess the feasibility of irrigation projects and site suitability;
- ii. Plan, design, and manage irrigation using soil-water-plant principles;
- iii. Install, operate, maintain, and troubleshoot irrigation and automation systems;
- iv. Apply precision, digital, and climate-smart irrigation technologies;
- v. Manage drainage, water quality, watershed resources, and environmental impacts;
- vi. Implement irrigated crop production and related farm management practices;
- vii. Provide irrigation enterprise, advisory, and extension services within relevant policy and safety standards.

4.0 ENTRY REQUIREMENTS

The minimum entry requirements into the ND Irrigation Agronomy Technology programme are:

- i. Four (4) credit-level passes in the Senior Secondary Certificate Examination (SSCE) — WAEC, NECO or NABTEB — obtained in not more than two sittings. The subjects must include English Language, Mathematics, Biology/Agricultural Science, and any one of: Geography, Economics, Technical Drawing or Physics.
- ii. Evidence of registration with the Joint Admissions and Matriculation Board (JAMB).

5.0 STRUCTURE/DURATION OF THE PROGRAMME

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

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

- i) 15 contact weeks of teaching (i.e. lectures and practical sessions, etc.) and
- ii) 2 weeks for registration and examinations.
- iii) The evaluation Scheme for the National Diploma in Irrigation Agronomy Technology Examination must be externally moderated. In grading the students, theory shall constitute 20% while Practical is 80%.

6.0 CURRICULUM

The syllabus of the ND Irrigation Agronomy programme consists of four (4) main components. These are:

- 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 core (4) qualified teaching staff with HND/BSc/MSc in Irrigation, Agronomy, Agricultural Engineering, Soil and Water Engineering, Water Resource Engineering, Climate Science, Agricultural Economics, Agribusiness, GIS / Remote Sensing, or related fields at good grade.

7.2 Technical Staff

There should be technical staff;

i) Technologist

A Technologist is a highly skilled professional trained at the Higher National Diploma (HND) level. They possess advanced technical and practical knowledge in their field and are capable of supervising operations, managing projects, operating modern equipment, and applying technology to solve practical problems. In agriculture, technologists help in farm management, research support, and the application of improved technologies.

ii) Technician

A Technician is a middle-level manpower trained at the National Diploma (ND) level. Technicians are responsible for carrying out technical tasks, operating tools and equipment, and assisting technologists and professionals in practical activities. In agriculture, they assist in crop production, livestock management, farm maintenance, and data collection.

iii) Farm Assistants

Farm assistants are support workers who help in daily farm operations under supervision. They perform basic practical activities such as planting, weeding, feeding animals, harvesting, cleaning farm tools, and maintaining farm records. They contribute to the smooth running of farm activities and help improve productivity.

7.3 Headship of the Department (HOD)

The Head of Department shall have at least a First and Master's Degree in Irrigation Agronomy or related field, He or she shall not be less than the rank of a Senior Lecturer and must be registered with the relevant professional body and must have a minimum of (12 years) experience in both academic and industry.

8.0 CERTIFICATION

A diplomate of this programme shall be awarded a National Diploma (ND) in Irrigation Agronomy 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.

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 Irrigation Agronomy Technology 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 PROJECT

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

13.0 Guidance Notes for Teachers of the Programme:

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

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

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

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

14.0 GUIDELINES ON 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

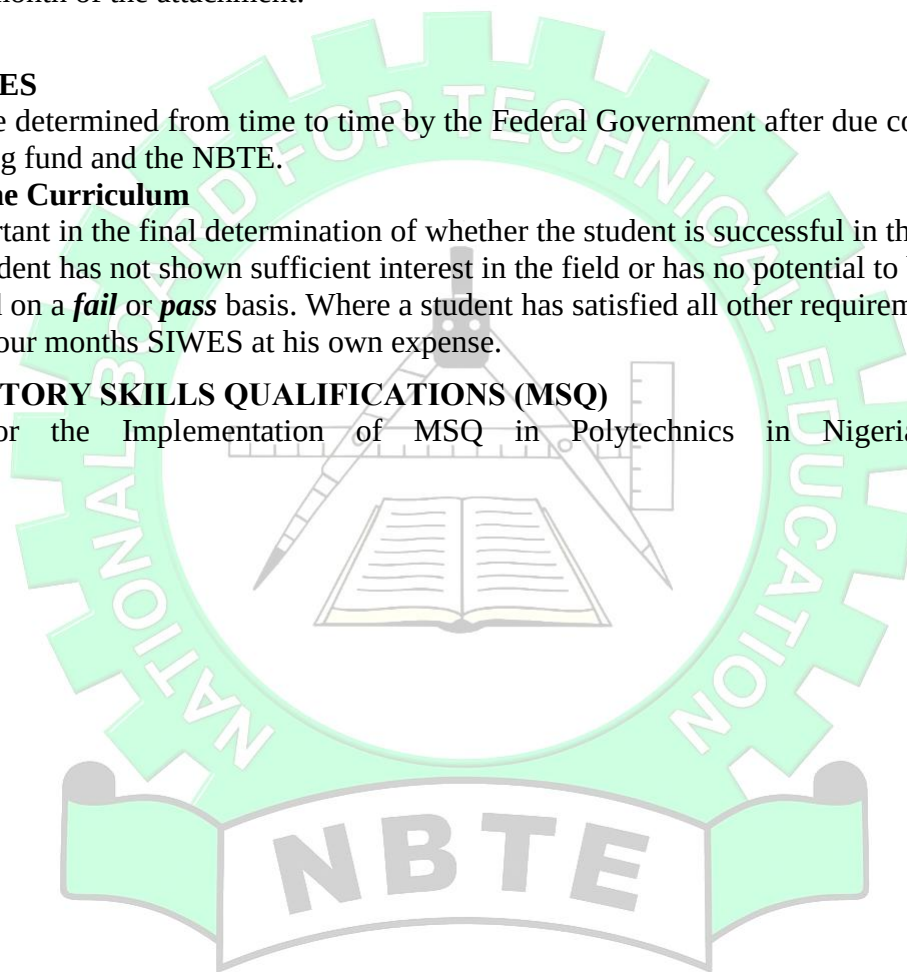
The rate of stipend payable shall be determined from time to time by the Federal Government after due consultation with the Federal Ministry of Education, the Industrial Training fund and the NBTE.

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 TABLE

Year I - Semester I

S/N	COURSE CODE	COURSE TITLE	L	T	P	CU	CH
1.	GNS 101	Use of English I	2	0	0	2	2
2.	GNS 111	Citizenship Education I	2	0	0	2	2
3.	COM 111	Introduction to Computing	2	0	2	4	4
4.	MSQ 111	Mandatory Skills Qualification	1	0	1	2	2
5.	MEC 113	Basic Workshop Technology and Practice	1	0	3	4	4
6.	AGR 101	Introduction to Agriculture	1	0	2	3	3
7.	AGT 112	Soil Health and Digital Land Management	1	0	3	4	4
8.	IAT 111	Principles of Irrigation Agronomy	1	0	2	3	3
9.	IAT 112	Soil–Water–Plant Relationships	1	0	2	3	3
10.	IAT 113	Introduction to Irrigation and Drainage Systems	1	0	2	3	3
11.	IAT 114	Basic Crop Water Requirement and Irrigation Scheduling	1	0	2	3	3
12.	IAT 115	Farm Hydraulics and Water Flow Principles	1	0	2	3	3
13.	IAT 116	Introduction to Digital Agriculture and Smart Irrigation	1	0	2	3	3
TOTAL			16	0	23	39	39

Year I - Semester II

S/N	COURSE CODE	COURSE TITLE	L	T	P	CU	CH
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.	AGT 125	Agro-Climatology	1	0	2	3	3
5.	IAT 121	Surface, Sprinkler and Drip Irrigation Systems	1	0	3	4	4
6.	IAT 122	Soil Moisture Measurement and Field Techniques	0	0	4	4	4
7.	IAT 123	Practical Irrigation Installation and Field Operations I	0	0	4	4	4
8.	IAT 124	Principles of Irrigation Surveying	1	0	3	4	4
9.	IAT 125	Drainage Technology	1	0	2	3	3
10.	IAT 126	Smart Irrigation Systems (IOT, Sensors And Automation Basics)	0	0	4	4	4
11.	IAT 127	Climate Change and Water Resource Planning	1	0	3	4	4
TOTAL			11	0	26	37	37

Year II- Semester I

S/N	COURSE CODE	COURSE TITLE	L	T	P	CU	CH
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.	IAT 211	Introduction to Irrigation Design	1	0	2	3	3
5.	IAT 212	Precision Irrigation and Sensor-based Water Management	1	0	2	3	3
6.	IAT 213	Irrigation Agronomy II	1	0	2	3	3
7.	IAT 214	Climate-smart Irrigation Systems and Drought Management	1	0	2	3	3
8.	IAT 215	Irrigation Maintenance, Repair and Automation systems	1	0	2	3	3
9.	IAT 216	Introduction to GIS and Remote Sensing for Water Monitoring Systems	1	0	2	3	3
10.	IAT 217	Practical Irrigation Operations II (system deployment)	0	0	3	3	3
11.	IAT 218	SIWES	0	0	4	4	4
TOTAL			11	0	21	32	32

Year II- Semester II

S/N	COURSE CODE	COURSE TITLE	L	T	P	CU	CH
1.	AGT 226	Agricultural Extension, Digital Advisory System and Rural Development	1	0	1	2	2
2.	IAT 221	Irrigation Enterprise Economics and Farm Water Business Models	1	0	2	3	3
3.	IAT 222	Water Resource Governance and Policy In Agriculture	1	0	2	3	3
4.	IAT 223	Agribusiness Of Irrigation Systems and Service Delivery	1	0	2	3	3
5.	IAT 224	Climate Risk Analysis in Irrigation Planning	1	0	3	4	4
6.	IAT 225	Soil and Water Conservation for Irrigation	1	0	2	3	3
7.	IAT 226	Project	0	0	4	4	4
TOTAL			6	0	16	22	22

KEYS:

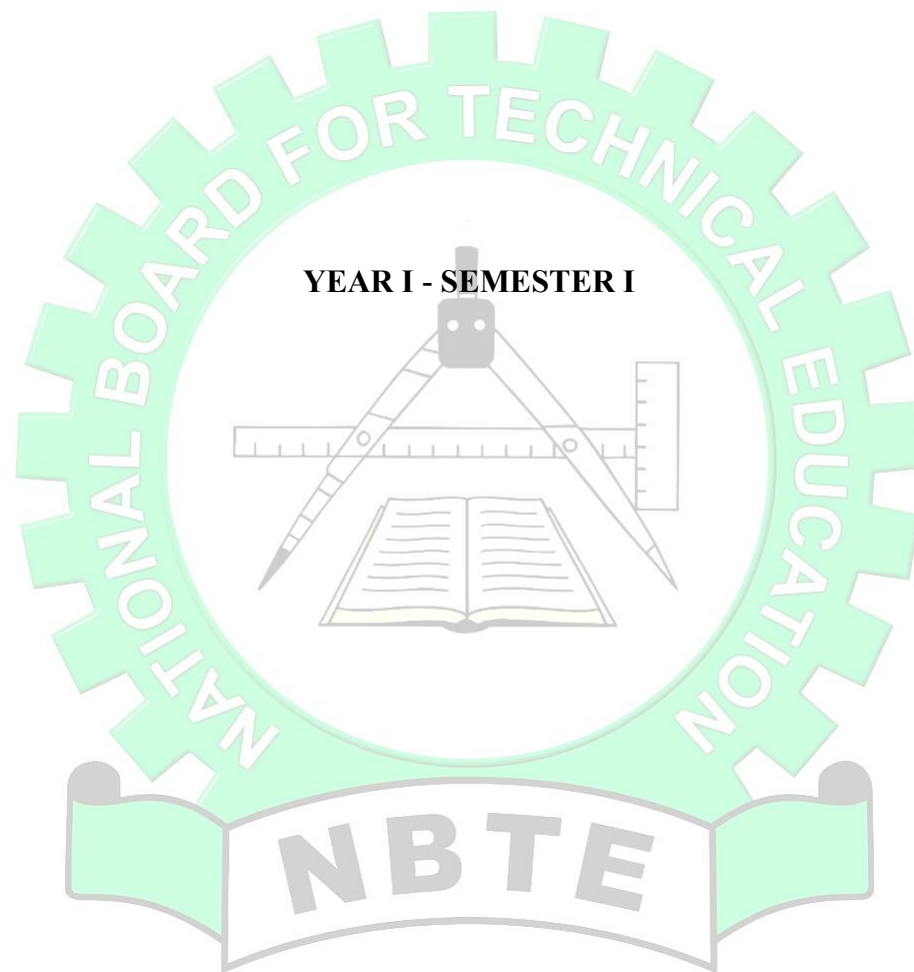
L= Lectures (hours/week)

T= Tutorial (hours/week)

P= Practical (hours/week)

CH=Contact Hours (hours/week)

CU=Credit Unit



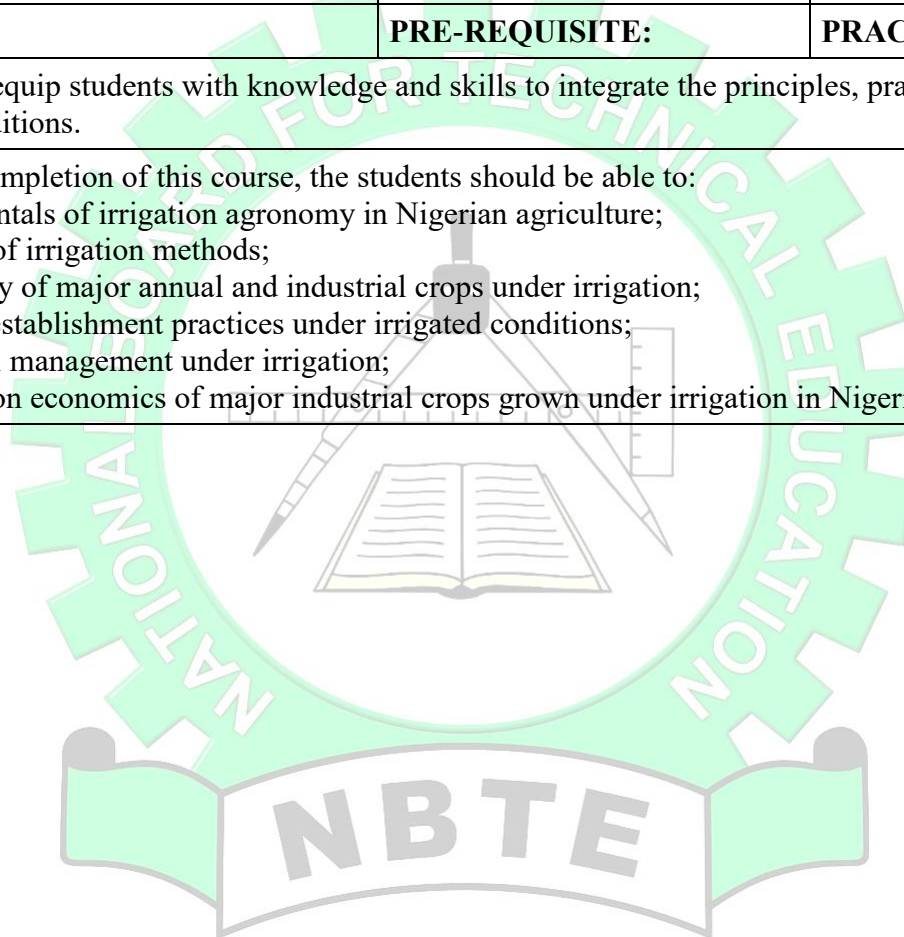
PRINCIPLES OF IRRIGATION AGRONOMY**PROGRAMME: NATIONAL DIPLOMA (ND) IRRIGATION AGRONOMY TECHNOLOGY**

COURSE TITLE: PRINCIPLES OF IRRIGATION AGRONOMY	COURSE CODE: IAT 111	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 to integrate the principles, practices of producing field and industrial crops under irrigated conditions.

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

- 1.0 Understand the fundamentals of irrigation agronomy in Nigerian agriculture;
- 2.0 Know the classification of irrigation methods;
- 3.0 Understand the agronomy of major annual and industrial crops under irrigation;
- 4.0 Know appropriate field establishment practices under irrigated conditions;
- 5.0 Understand crop and soil management under irrigation;
- 6.0 Understand the production economics of major industrial crops grown under irrigation in Nigeria.



PROGRAMME: NATIONAL DIPLOMA (ND) IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: PRINCIPLES OF IRRIGATION AGRONOMY			COURSE CODE: IAT 111		CONTACT HOURS: 3 HOURS/WEEK	
YEAR: I SEMESTER: I			CREDIT UNIT: 3		THEORETICAL: 2. HOURS/WEEK	
			PRE-REQUISITE:		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills to integrate the principles, practices of producing field and industrial crops under irrigated conditions.						
General Objective 1.0: Understand the fundamentals of irrigation agronomy in Nigerian agriculture						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Define agronomy, irrigation, and irrigation agronomy. 1.2 Explain the historical development of irrigation worldwide. 1.3 Explain the historical development of irrigation in Nigeria. 1.4 Explain the importance of irrigation to sustainable food security, employment and climate adaptation (year-round production, drought escape, intensification) 1.5 Differentiate between	• Explain the scope of irrigation agronomy, using local examples. • Discuss the history with case studies (e.g. Egyptian civilization, Nigerian river basins). • Discuss the importance of irrigation using statistics from FAO and NBS.	Textbooks, LCD projector, Whiteboard, Slides	• Visit one irrigation scheme (e.g., Bakolori, Hadejia-Jama'are, Sokoto-Rima, or nearest scheme). • Document scheme history, command area, and water source on a field sheet. • Interview scheme operators on operations and benefits. • Compile field report with	Guide students to: • Visit one irrigation scheme (e.g., Bakolori, Hadejia-Jama'are, Sokoto-Rima, or nearest scheme). • Document scheme history, command area, and water source on a field sheet. • Interview scheme operators on operations and benefits. • Compile field report with photographs.	Field notebooks, Cameras, Scheme map, Report templates Case studies, Calculators, Scheme records Etc.

	rain-fed and irrigated agriculture. 1.6 Describe the limitations of irrigation (soil salinity, sodicity, waterlogging, capital cost, equipment maintenance). 1.7 Explain irrigation as a tool for climate adaptation.	• Compare rain-fed vs irrigated yields using data. • Discuss benefits with examples of year-round vegetable production. • Discuss limitations with case examples (e.g., salinization in Jigawa, waterlogging in Kebbi etc). • Link irrigation to climate resilience (e.g., drought escape during dry spells).		photographs.		
GENERAL OBJECTIVE 2.0: Know the classification of irrigation methods						
4-6	2.1 Explain the classification of irrigation methods: - Surface (Basin, Border, Furrow); - Pressurized (Sprinkler, Drip); - Sub-surface. 2.2 Explain factors influencing the choice of irrigation method	• Explain the classification of irrigation methods: - Surface (Basin, Border, Furrow); - Pressurized	Textbooks, LCD projector, Whiteboard, Slides	• Inspect samples or models of each irrigation method on the demonstration plot. • Conduct a comparison matrix scoring method against	Guide students to: • Inspect samples or models of each irrigation method on the demonstration plot. • Conduct a comparison matrix scoring method against five chosen factors. • Measure water flow rate	Demo plot with surface, Sprinkler, Drip kits, Pipes, Stopwatch, Bucket, Smart controller kit, Solenoid valve, GPS device, EC

	(crop, soil, topography, water source, capital, labour etc.). 2.3 Distinguish between water-use efficiency across methods. 2.4 Describe surface water sources (rivers, lakes, reservoirs, dams etc.). 2.5 Explain groundwater sources (shallow wells, tube wells, boreholes etc.). 2.6 Outline alternative sources (rainwater harvesting, treated wastewater etc.). 2.7 Explain water quality parameters for irrigation (EC, pH, SAR etc.). 2.8 Explain smart-irrigation methods as a modern evolution.	(Sprinkler, Drip); - Sub-surface. • Discuss factors influencing the choice of irrigation method (crop, soil, topography, water source, capital, labour etc.). • Distinguish between water-use efficiency across methods. • Describe surface water sources (rivers, lakes, reservoirs, dams etc.). • Explain groundwater sources (shallow wells, tube wells, boreholes etc.). • Discuss alternative sources (rainwater harvesting, treated wastewater etc.). • Explain water		five chosen factors. • Measure water flow rate from each method using a stopwatch and bucket. • Demonstrate a basic smart-irrigation controller turning a solenoid valve. • Map all water sources within a 5 km radius of the institution using GPS. • Visit a borehole • Document depth, yield, and pump capacity. • Collect three water samples • Test EC and pH using portable meters. • Interpret water quality results.	from each method using a stopwatch and bucket. • Demonstrate a basic smart-irrigation controller turning a solenoid valve. • Map all water sources within a 5 km radius of the institution using GPS. • Visit a borehole • Document depth, yield, and pump capacity. • Collect three water samples and • Test EC and pH using portable meters. • Interpret water quality results.	meter, PH meter, Sample bottles, Borehole site Etc.
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		quality parameters for irrigation (EC, pH, SAR etc.). • Discuss smart-irrigation methods as a modern evolution.				
GENERAL OBJECTIVE 3.0: Understand the agronomy of major annual and industrial crops under irrigation						
7-9	3.1 Explain botanical and agricultural classification (cereals, legumes and root/tubers). 3.2 Outline major industrial crops (cotton, grape, sugarcane, cocoa, oil palm, etc.). 3.3 Describe the origin, history, and adaptation of key crops to Nigerian conditions. 3.4 State the producing areas of major industrial crops in Nigeria. 3.5 Explain the principles of fertiliser application under irrigation. 3.6 Define cropping intensity and explain how irrigation supports double/triple cropping. 3.7 Explain crop rotation principles in irrigated	• Explain botanical and agricultural classification (cereals, legumes and root/tubers). • Discuss major industrial crops (cotton, grape, sugarcane, cocoa, oil palm, etc.). • Explain the origin, history, and adaptation of key crops to Nigerian conditions. • State the producing areas of major industrial crops	Textbooks, LCD projector, Whiteboard, Slides	• Identify seeds, seedlings, and mature plant structures of annual crops (maize, rice, cowpea). • Identify seeds, seedlings, and structures of industrial crops (cotton, grapes, sugarcane, cocoa, oil palm). • Calculate fertiliser application rate for a 0.5-ha plot of a chosen crop. • Inspect a fertigation injector • Identify all parts. • Design a 3-crop annual rotation plan for a 1-ha	Guide students to: • Identify seeds, seedlings, and mature plant structures of annual crops (maize, rice, cowpea). • Identify seeds, seedlings, and structures of industrial crops (cotton, grapes, sugarcane, cocoa, oil palm). • Calculate fertiliser application rate for a 0.5-ha plot of a chosen crop. • Inspect a fertigation injector • Identify all parts. • Design a 3-crop annual rotation plan for a 1-ha irrigated plot. • Apply NPK fertiliser to a demonstration plot following the calculated rate.	Seed samples Seedlings, Hand lenses, Fertiliser (NPK), Fertigation injector, Measuring scale, Demo plot, Paper for rotation plans, Calculators, Etc.

	systems.	- in Nigeria. • Discuss the principles of fertiliser application under irrigation. • Explain cropping intensity and explain how irrigation supports double/triple cropping. • Describe crop rotation principles in irrigated systems.		- irrigated plot. • Apply NPK fertiliser to a demonstration plot following the calculated rate.		
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GENERAL OBJECTIVE 4.0: Know appropriate field establishment practices under irrigated conditions

10-11	4.1 Explain principles of primary and secondary tillage for irrigated plots. 4.2 Explain the importance of land levelling for surface irrigation. 4.3 State correct seed rate, spacing, and planting depth for major irrigated crops. 4.4 Differentiate between direct seeding vs	• Discuss principles of primary and secondary tillage for irrigated plots. • Explain the importance of land levelling for surface irrigation. • Outline correct seed rate, spacing, and planting depth for major irrigated crops.	Textbooks, LCD projector, Whiteboard, Slides	• Carry out primary and secondary tillage on a 0.25-ha plot. • Level a plot using simple methods (spirit level/water tube) • Form ridges/beds. • Calculate seed rate for a 0.25-ha tomato or maize plot. • Prepare a nursery bed • Transplant seedlings. • Collect common weeds from the field	Guide students to: • Carry out primary and secondary tillage on a 0.25-ha plot. • Level a plot using simple methods (spirit level/water tube) • Form ridges/beds. • Calculate seed rate for a 0.25-ha tomato or maize plot. • Prepare a nursery bed • Transplant seedlings. • Collect common	Tractor Disc plough, Harrow, Hand hoes, Rakes, Levelling tools, Measuring tape, Pegs, String, Seeds, Nursery site, Watering cans, Weed album materials,
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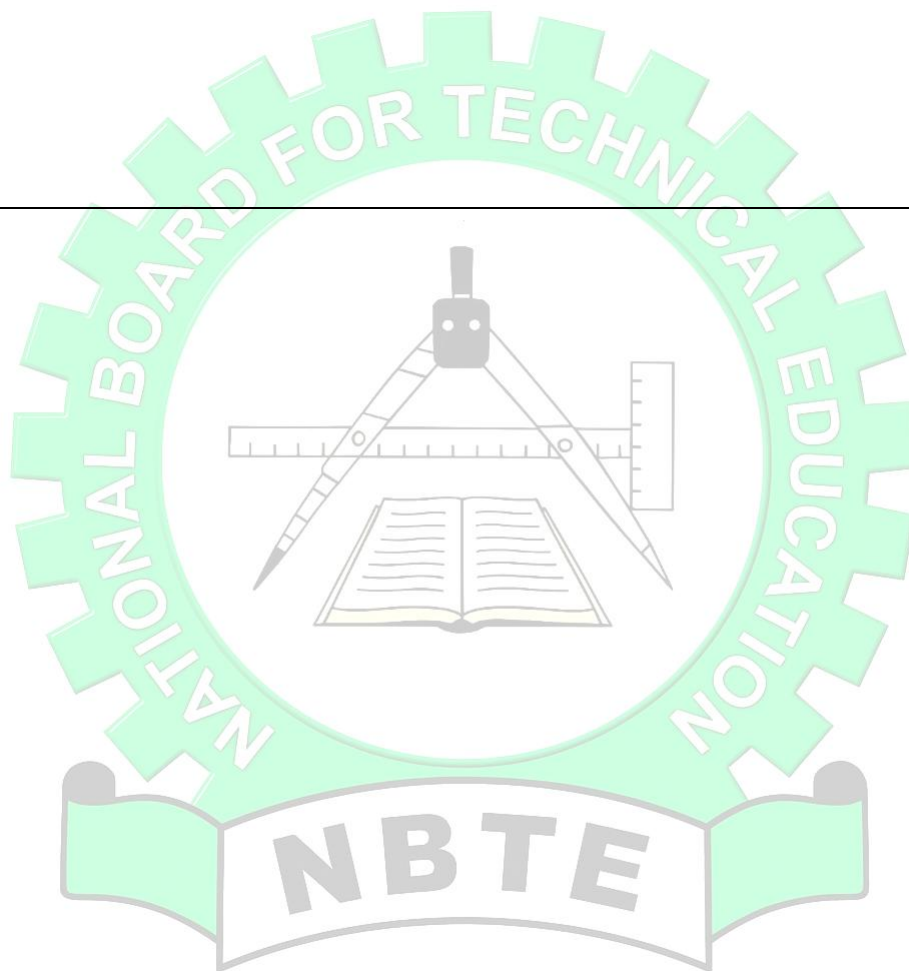
	transplanting. 4.5 Explain common weeds in irrigated farms and their effects on yield. 4.6 Explain the methods of weed control (cultural, mechanical, biological and chemical).	• Discuss direct seeding vs transplanting. • Explain common weeds in irrigated farms and their effects on yield. • Explain the methods of weed control (cultural, mechanical, biological and chemical).		to start a weed album. • Carry out mechanical weed control (hand hoeing) on the demo plot.	weeds from the field to start a weed album. • Carry out mechanical weed control (hand hoeing) on the demo plot.	Demo plot (0.25 ha)
GENERAL OBJECTIVE 5.0: Understand crop and soil management under irrigation.						
12-13	5.1 Explain crop rotation principles and benefits in irrigated systems. 5.2 Describe the effects of irrigation on soil health (salinity, waterlogging, compaction etc.). 5.3 Describe major insect pests and diseases of irrigated crops and their symptoms. 5.4 Explain the principles of Integrated Pest Management (IPM). 5.5 Explain the principles of fertilizer application under irrigation (basal	• Discuss crop rotation principles and benefits in irrigated systems. • Explain the effects of irrigation on soil health (salinity, waterlogging, compaction etc.). • Describe major insect pests and diseases of irrigated crops and their symptoms. • Discuss the principles of Integrated Pest Management (IPM).	Textbooks, LCD projector, Whiteboard, Slides	• Design a 3-year crop rotation plan for a 0.5-ha irrigated farm. • Compare soil structure in a well-managed plot versus a degraded or waterlogged area. • Identify insect pests and disease symptoms on crops in the demo plot. • Demonstrate the safe mixing and application of a pesticide using a knapsack sprayer. • Calculate	Guide students to; • Design a 3-year crop rotation plan for a 0.5-ha irrigated farm. • Compare soil structure in a well-managed plot versus a degraded or waterlogged area. • Identify insect pests and disease symptoms on crops in the demo plot. • Demonstrate the safe mixing and application of a pesticide using a	Hand hoes, Weed album materials (paper, glue, samples), Knapsack sprayer, PPEs, Pesticides (sample/demonstration), NPK fertilizer, Measuring scale, Demo plot, Fertigation injector, Drip kit Etc.

	vs. top-dressing). 5.6 Outline the problems associated with fertilizer use (e.g., salinity, leaching).	• Discuss the principles of fertilizer application under irrigation (basal vs. top-dressing). • Highlight the problems associated with fertilizer use (e.g., salinity, leaching).		recommendation rate fertilizer (NPK). • Apply basal fertilizer (NPK) to the demo plot based on the recommended rate. • Demonstrate the operation of a fertigation injector.	knapsack sprayer. • Calculate recommendation rate fertilizer (NPK). • apply basal fertilizer (NPK) to the demo plot based on the recommended rate. • Demonstrate the operation of a fertigation injector.	
GENERAL OBJECTIVE 6.0: Understand the production economics of major industrial crops grown under irrigation in Nigeria						
14-15	6.1 Describe the life cycle of a key industrial crop (cotton, sugarcane, or oil palm) from planting to harvest. 6.2 Describe the yield capacity, profitability, and economic importance of industrial crops in Nigeria. 6.3 Explain challenges facing industrial crop production under irrigation (pests,	• Describe with the use of diagrams and case studies the production cycle (planting → vegetative → flowering → maturity → harvest). • Discuss the value chain for the selected crop Present typical yield ranges (kg/ha) and profitability estimates. • Discuss challenges (e.g., pest pressure, water demand for the selected crops).	Textbooks, LCD projector, Whiteboard, Slides	• Prepare a flow chart or short presentation summarizing the production cycle, inputs, and major costs/revenues for a chosen industrial crop (cotton or sugarcane). • Present findings to the class and participate in a group discussion on the economic importance of industrial crops.	Guide students to: • Prepare a flow chart or short presentation summarizing the production cycle, inputs, and major costs/revenues for a chosen industrial crop (cotton or sugarcane). • Present findings to the class and participate in a group discussion on the economic importance of industrial crops.	Internet access, Chart paper, Markers, Laptops, Presentation software.

	diseases, market access, input costs).					
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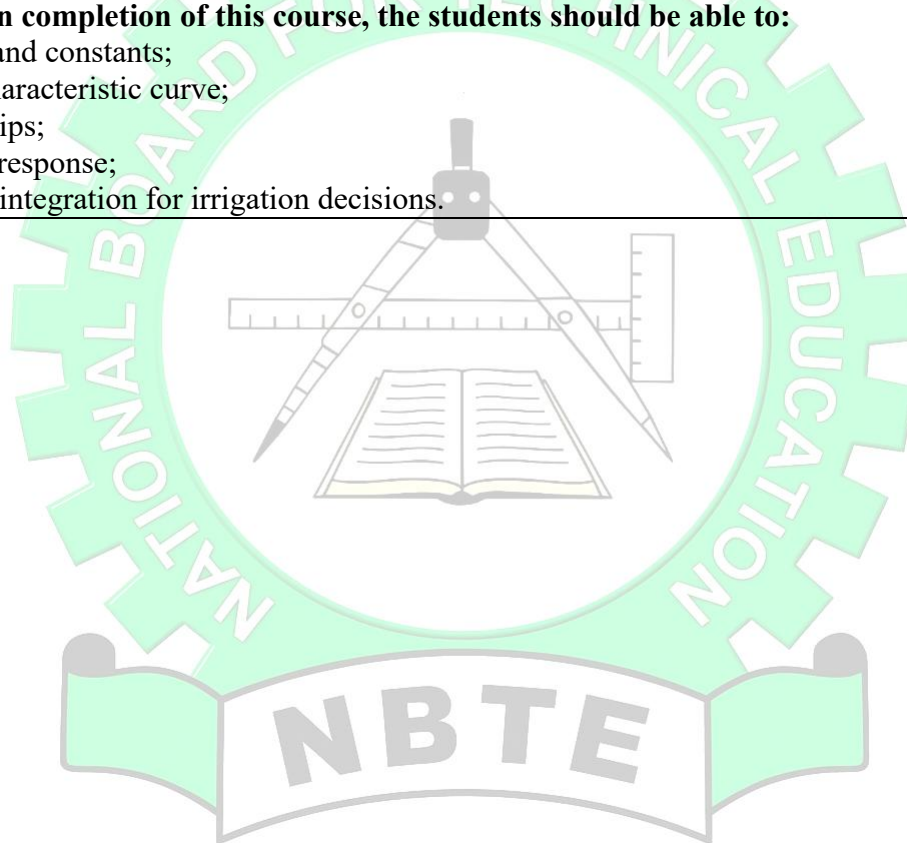
COURSE ASSESSMENT:

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



SOIL–WATER–PLANT RELATIONSHIPS

PROGRAMME: NATIONAL DIPLOMA (ND) IRRIGATION AGRONOMY TECHNOLOGY		
COURSE TITLE: SOIL–WATER–PLANT RELATIONSHIPS	COURSE CODE: IAT 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 physical and physiological relationships between soil, water and plants that govern crop water use and form the scientific basis of irrigation scheduling.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Know soil-water properties and constants; 2.0 Understand the soil-water characteristic curve; 3.0 Know plant-water relationships; 4.0 Know water stress and crop response; 5.0 Understand soil-water-plant integration for irrigation decisions.		



PROGRAMME: NATIONAL DIPLOMA (ND) IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: SOIL–WATER–PLANT RELATIONSHIPS			COURSE CODE: IAT 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 physical and physiological relationships between soil, water and plants that govern crop water use and form the scientific basis of irrigation scheduling.						
GENERAL OBJECTIVE 1.0: Know soil-water properties and constants.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1 – 3	1.1 Explain soil composition, texture, structure and pore spaces. 1.2 Define soil-water content (gravimetric and volumetric). 1.3 Define soil-water constants: saturation, field capacity, and permanent wilting point. 1.4 Explain the following: i. Gravitational water; ii. Capillary water; iii. Available water; iv. Readily available water;	• Discuss soil composition, texture, structure and pore spaces. • Describe soil-water content (gravimetric and volumetric). • Explain soil-water constants: saturation, field capacity, and permanent wilting point. • Explain the following: - Gravitational water; - Capillary water; - Available water; - Readily available water; - Hygroscopic water. • Discuss soil moisture tension, soil-water potential (matric,	Textbooks, LCD projector, Whiteboard, Slides	• Identify soil types and texture classes. • Determine gravimetric soil-water content of three soil samples using the oven-dry method. • Determine field capacity using the field method (covered plot 48 hrs after wetting). • Determine bulk density • Convert gravimetric to volumetric content. • Plot the soil-water-content vs depth curve for one soil profile.	Guide students to: • Identify soil types and texture classes. • Determine gravimetric soil-water content of three soil samples using the oven-dry method. • Determine field capacity using the field method (covered plot 48 hrs after wetting). • Determine bulk density • Convert gravimetric to volumetric content. • Plot the soil-water-content vs depth curve for one soil	Soil sample Texture triangle Auger Core sampler Tensiometer Sandy, loamy clay

	v. Hygroscopic water. 1.5 Explain soil moisture tension, soil-water potential (matric, osmotic, gravitational). 1.6 Explain factors affecting water retention in soil (infiltration, organic matter content, permeability, structure, porosity, bulk density and slope etc).	osmotic, gravitational). Explain factors affecting water retention in soil (infiltration, organic matter content, permeability, structure, porosity, bulk density and slope etc).		- Measure soil moisture tension. - Compare water retention among soils.	profile. - Measure soil moisture tension. - Compare water retention among soils.	
General Objective 2.0: Understand the soil-water characteristic curve.						
3 – 5	2.1 Explain the soil-water characteristic curve (SWCC). 2.2 Differentiate SWCC of sandy, loamy, and clay soils. 2.3 Describe hysteresis in SWCC. 2.4 Explain how to apply SWCC to irrigation-scheduling decisions.	- Discuss the soil-water characteristic curve (SWCC). - Differentiate SWCC of sandy, loamy, and clay soils. - Explain hysteresis in SWCC. - Discuss how to apply SWCC to irrigation-scheduling decisions.	Textbooks, LCD projector, Whiteboard, Slides	- Construct a simple SWCC for one soil using pressure-plate or tensiometer readings. - Compare the SWCC of three different soil textures from the supplied data. - Calculate available water for each soil from its SWCC. - Use SWCC to recommend irrigation timing for a sample crop.	Guide students to: - Construct a simple SWCC for one soil using pressure-plate or tensiometer readings. - Compare the SWCC of three different soil textures from the supplied data. - Calculate available water for each soil from its SWCC. - Use SWCC to recommend irrigation timing for a sample crop.	Pressure-plate apparatus, Tensiometers, Soil samples, Graph paper, Calculators

General Objective 3.0: Know plant-water relationships						
6-9	3.1 Explain water uptake by roots and transpiration. 3.2 Define crop water requirement (CWR) and evapotranspiration (ET). 3.3 Distinguish reference ET (ET _o), crop ET (ET _c), and actual ET (ET _a). 3.4 Explain crop coefficients (K _c) and growth-stage water demand.	• Discuss water uptake by roots and transpiration. • Describe crop water requirement (CWR) and evapotranspiration (ET). • Explain reference ET (ET_o), crop ET (ET_c), and actual ET (ET_a). • Explain crop coefficients (K_c) and growth-stage water demand.	Textbooks, LCD projector, Whiteboard, Slides	• Measure transpiration using a potometer and lysimeter on a potted plant. • Calculate ET_o using FAO-56 reference values for the locality. • Calculate ET_c for maize at four growth stages using K_c values. • Plot K_c curve over the crop season for one chosen crop.	Guide students to: • Measure transpiration using a potometer and lysimeter on a potted plant. • Calculate ET_o using FAO-56 reference values for the locality. • Calculate ET_c for maize at four growth stages using K_c values. • Plot K_c curve over the crop season for one chosen crop.	Potometer, Potted plants, FAO-56 reference, Calculators, Graph paper, Class A pan, Lysimeter
General Objective 4.0: Know water stress and crop response						
10-12	4.1 Define water stress and stress indicators (leaf rolling, wilting, stomatal closure). 4.2 Explain critical growth stages for water stress (flowering, grain-fill). 4.3 Explain the concept of maximum allowable depletion (MAD). 4.4 Explain deficit-	• Explain water stress and stress indicators (leaf rolling, wilting, stomatal closure). • Discuss critical growth stages for water stress (flowering, grain-fill). • Describe the concept of maximum allowable depletion (MAD). • Discuss deficit-irrigation strategies as climate adaptation.	Textbooks, LCD projector, Whiteboard, Slides	• Record stress symptoms on water-stressed plot vs irrigated plot. • Identify the current growth stage of a sample crop in the demo plot. • Calculate MAD for one crop-soil combination. • Design a deficit-irrigation schedule for one drought-tolerant crop.	Guide students to: • Record stress symptoms on water-stressed plot vs irrigated plot. • Identify the current growth stage of a sample crop in the demo plot. • Calculate MAD for one crop-soil combination. • Design a deficit-irrigation schedule for one drought-	Two demo plots, Identification charts, Calculators, Schedule templates, Screen house

	irrigation strategies as climate adaptation.				tolerant crop.	
GENERAL OBJECTIVE 5.0: Know soil-water-plant integration for irrigation decisions						
13-15	5.1 Explain Integrate SWCC, ET, and growth stage into water-balance calculations. 5.2 Explain the use of the water-balance method to determine irrigation depth. 5.3 Explain how soil and crop factors interact to determine the irrigation interval. 5.4 Explain how to apply soil-water-plant principles to one major crop (rice, tomato, or wheat).	- Describe Integrate SWCC, ET, and growth stage into water-balance calculations. - Explain the use of the water-balance method to determine irrigation depth. - Discuss how soil and crop factors interact to determine the irrigation interval. - Explain how to apply soil-water-plant principles to one major crop (rice, tomato, or wheat).	Textbooks, LCD projector, Whiteboard, Slides	- Perform a soil-water balance for one week on the demo plot. - Calculate irrigation depth from soil-water deficit. - Determine irrigation interval for chosen crop using measured ET. - Compile a 3-page soil-water-plant integration report for one crop.	Guide students to: - Perform a soil-water balance for one week on the demo plot. - Calculate irrigation depth from soil-water deficit. - Determine irrigation interval for chosen crop using measured ET. - Compile a 3-page soil-water-plant integration report for one crop.	Demo plots Soil moisture probes, Calculators, worksheets, and templates
COURSE ASSESSMENT: Coursework: 10% Test/Assignments: 10% Practical: 60% Examination: 20% Total: 100%						

INTRODUCTION TO IRRIGATION AND DRAINAGE

PROGRAMME: NATIONAL DIPLOMA (ND) IRRIGATION AGRONOMY TECHNOLOGY		
COURSE TITLE: INTRODUCTION TO IRRIGATION AND DRAINAGE	COURSE CODE: IAT 113	CONTACT HOURS: 3 HOURS/WEEK
	CREDIT UNIT: 3	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: I	PRE-REQUISITE: NIL	PRACTICAL: 2 HOURS/WEEK
Goal: This course is designed to equip students with knowledge and skills in irrigation and drainage systems including modern technologies for sustainable agricultural production.		
GENERAL OBJECTIVES: On completion of this module, the student should be able to: 1.0 Understand the concept of irrigation and drainage; 2.0 Understand the water requirements of crops; 3.0 Know the sources of irrigation water; 4.0 Understand effects of water stress on crop growth stages; 5.0 Know irrigation structures and pumps; 6.0 Understand irrigation water application methods and scheduling. 7.0 Understand the principles of water conservation and supply		

PROGRAMME: NATIONAL DIPLOMA (ND) IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: INTRODUCTION TO IRRIGATION AND DRAINAGE			COURSE CODE: IAT 113		CONTACT HOURS: 3 HOURS/WEEK	
			CREDIT UNIT: 3		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: I			PRE-REQUISITE: NIL		PRACTICAL: 2 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
Goal: This course is designed to equip students with knowledge and skills in irrigation and drainage systems including modern technologies for sustainable agricultural production.						
GENERAL OBJECTIVE 1.0: Understand the concept of irrigation and drainage.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1	1.1 Define irrigation and drainage.	• Explain irrigation and drainage. • Differentiate between irrigation and drainage. • Discuss the problems associated with irrigation and drainage • Explain the prospects of applying modern irrigation technologies for sustainable agriculture in Nigeria.	Projector, Whiteboard, Markers E-library Textbooks	• Identify irrigation and schemes.	Guide students to: • Identify irrigation and schemes.	Venues with modern irrigation facilities
	1.2 Differentiate between irrigation and drainage.					
	1.3 Describe the problems associated with irrigation and drainage					
2	1.4 Describe the prospects of applying modern irrigation technologies for sustainable agriculture in Nigeria.					

GENERAL OBJECTIVE 2.0: Understand the water requirements of crops.

3	2.1 Explain the uses of water in plants. 2.2 Explain the different forms of soil moisture e.g. gravitational water, capillary water and hygroscopic water. 2.3 Explain the concept of available water, field capacity and permanent wilting point etc.	• Explain the uses of water in plants. • Discuss the different forms of soil moisture e.g. gravitational water, capillary water and hygroscopic water. • Describe the concept of available water, field capacity and permanent wilting point etc.	Projector, White board, Markers E-library Textbooks	• Observe how water is held in soil. • Calculate the water requirements for selected crop.	Guide the students to: • Observe how water is held in soil. • Calculate the water requirements for selected crop.	Soil samples, water Lysimeters, Pan evaporation meter, Meteorological station
3-4	2.4 Describe the water requirements of crops. 2.5 Describe irrigation water requirements e.g. the consumptive use. 2.6 State the major criteria to determine water quality. 2.7 Outline irrigation water based on qualities. 2.8 Explain the mechanisms and importance of evapotranspiration	• Explain the water requirements of crops. • Explain irrigation water requirements e.g. the consumptive use. • Highlight the major criteria to determine water quality. • Explain irrigation water based on qualities. • Describe the mechanisms and importance of evapotranspiration				

GENERAL OBJECTIVE 3.0: Know the sources of irrigation water.

5-6	3.1 Explain sources of water for irrigation. 3.2 State the forms in which Ground water exists. 3.3 Explain Ground water yield. 3.4 Explain discharge from wells.	• Explain sources of water for irrigation. • State the forms in which Ground water exists. • Explain Ground water yield. • Explain discharge from wells.	Projector, Slide, White board, Markers.	• Identify sources of irrigation water. • Estimate ground water yield.	Guide students to: • Identify sources of irrigation water. • Estimate ground water yield.	Suitable visit venues. Water meters and flumes
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GENERAL OBJECTIVE 4.0: Understand effects of water stress on crop growth.

7	4.1 Explain the concept of water stress. 4.2 Explain the effects of water stress on crops. 4.3 Explain the beneficial effects of water stress to crops.	• Explain the concept of water stress. • Explain the effects of water stress on crops. • Explain the beneficial effects of water stress to crops.	Projector, Slide, White board, Markers.	• Observe the effect of water stress on the appearance of crops.	Guide students to: • Observe the effect of water stress on the appearance of crops.	Seeds Plastic pots Watering cans.
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GENERAL OBJECTIVE 5.0: Know irrigation structures and pumps.

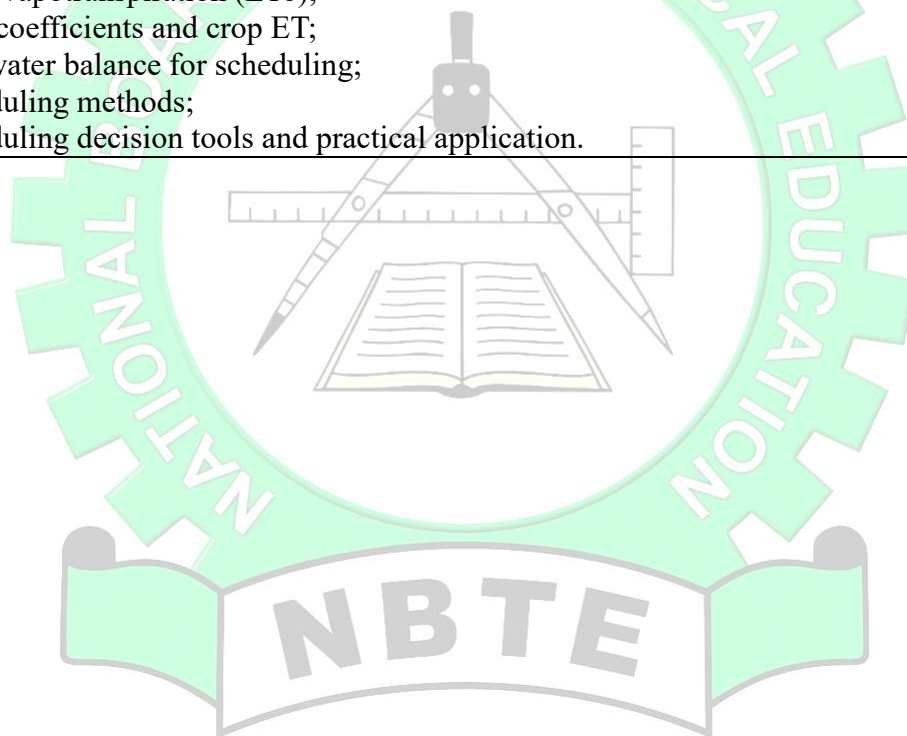
8-9	5.1 Explain modern irrigation water conveyance systems, water measurement devices, and their component parts. 5.2 Explain irrigation structures and water control structures such as off-takes, cross drainage works,	• Discuss modern irrigation water conveyance systems, water measurement devices, and their component parts. • Describe irrigation structures and water control structures such as off-takes, cross drainage works,	Projector, Slide, White board, Markers	• Visit irrigation farm • Identify structures used in irrigation on field. • Demonstrate irrigation pump maintenance	Guide students • Visit irrigation farm • Identify structures used in irrigation on field. • Demonstrate irrigation pump maintenance	Irrigation sites Different: Pumps Valves Pipes Sprinkler head Emitters Regulator Etc.
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	siphons, and lining of canals. 5.3 Outline types of irrigation pumps 5.4 State criteria for pump selection. 5.5 Explain the working principles of selected pumps.	siphons, and lining of canals. • State types of irrigation pumps • Highlight criteria for pump selection. • Discuss the working principles of selected pumps.				
General Objective 6.0 Understand irrigation water application methods and scheduling.						
10-13	6.1 Explain modern irrigation water application methods and their operational principles. 6.2 State the factors that determine the choice of irrigation methods. 6.3 Describe irrigation scheduling to make optimum use of water. 6.4 Explain how to calculate the depth of water application in irrigation.	• Describe modern irrigation water application methods and their operational principles. • Highlight the factors that determine the choice of irrigation methods. • Explain irrigation scheduling to make optimum use of water. • Discuss how to calculate the depth of water application in irrigation.	Projector, Slide, White board, Markers Pump charts	• Visit an existing irrigation project. • Observe irrigation water application methods. • Practice irrigation schedule methods.	Guide students to: • Visit an existing irrigation project. • Observe irrigation water application methods. • Practice irrigation schedule methods.	Measuring Instruments, Smart Irrigation equipment, Demo plots Paper, calculators .
General Objective 7.0 Understand the principles of water conservation and supply.						
14 - 15	7.1 Explain the principles and importance of water conservation and	• Describe the principles and importance of water conservation and efficient water-use	Projector, Slide, White board, Markers	• Visits to irrigation farms. • Identify water conservation	Guide students to: • Visits to irrigation farms. • Identify water	Water supply, storage, and harvesting facilities,

	efficient water-use practices in modern irrigation systems. 7.2 Describe modern methods of water harvesting, storage, and conservation for sustainable farm water management. 7.3 Describe modern water storage methods and facilities used for irrigation and agricultural water supply. 7.4 Outline the development, operation, and management of water supply systems from boreholes, wells, reservoirs, and water-harvesting structures for irrigation and agricultural water use.	practices in modern irrigation systems. • Explain modern methods of water harvesting, storage, and conservation for sustainable farm water management. • Discuss modern water storage methods and facilities used for irrigation and agricultural water supply. • Explain the development, operation, and management of water supply systems from boreholes, wells, reservoirs, and water-harvesting structures for irrigation and agricultural water use.	Textbooks, Manuals, Multimedia materials	techniques. • Identify the ways of harnessing water resources.	conservation techniques. • Identify the ways of harnessing water resources.	Measuring and monitoring instruments, ICT and smart irrigation tools Demo Plots
COURSE ASSESSMENT: Coursework: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

BASIC CROP WATER REQUIREMENTS AND IRRIGATION SCHEDULING

PROGRAMME: NATIONAL DIPLOMA (ND) IRRIGATION AGRONOMY TECHNOLOGY		
COURSE TITLE: BASIC CROP WATER REQUIREMENTS AND IRRIGATION SCHEDULING	COURSE CODE: IAT 114	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 of crop water requirement and application of appropriate irrigation scheduling for efficient crop production		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Know reference evapotranspiration (ET_o); 2.0 Understand crop coefficients and crop ET; 3.0 Understand soil water balance for scheduling; 4.0 Understand scheduling methods; 5.0 Understand scheduling decision tools and practical application.		



PROGRAMME: NATIONAL DIPLOMA (ND) IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: BASIC CROP WATER REQUIREMENTS AND IRRIGATION SCHEDULING			COURSE CODE: IAT 114		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 of crop water requirement and application of appropriate irrigation scheduling for efficient crop production						
GENERAL OBJECTIVE 1.0: Know reference evapotranspiration (ET _o)						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Define Reference evapotranspiration (ET _o) 1.2 Explain its significance as a standard benchmark for measuring atmospheric water demand. 1.3 Describe the key meteorological parameters required for ET _o estimation. 1.4 Outline common ET _o estimation methods: i. FAO-56 Penman-Monteith; ii. Hargreaves-Samani; iii. Class A pan	• Discuss Reference evapotranspiration (ET_o) • Explain its significance as a standard benchmark for measuring atmospheric water demand. • Describe the key meteorological parameters required for ET_o estimation. • Outline common ET_o estimation methods: - FAO-56 Penman-Monteith; - Hargreaves-Samani; - Class A pan	Projector, Slides, White board, Markers Textbooks, Manuals, Multimedia materials	• Set up a class-A evaporation pan for 1 week. • Calculate ET_o using Hargreaves method from local temperature data. • Calculate ET_o using FAO Penman-Monteith using CLIMWAT or supplied data. • Compare ET_o values from the 3 methods and discuss differences.	Guide students to; • Set up a class-A evaporation pan for 1 week. • Calculate ET_o using Hargreaves method from local temperature data. • Calculate ET_o using FAO Penman-Monteith using CLIMWAT or supplied data. • Compare ET_o values from the 3 methods and discuss differences.	Class-A pan Thermometer Hygrometer r Wind anemometer r NIMET data IAR data Calculators

	evaporation methods; 1.5 Explain Retrieve ETo data from relevant National and International sources i.e. i. Nigerian Meteorological Agency (NIMET); ii. IAR; iii. FAO; iv. CLIMWAT database; v. Irrigation and Drainage Paper No. 56.	evaporation methods; • Retrieve ETo data from relevant National and International sources i.e. - Nigerian Meteorological Agency (NIMET) - IAR - FAO - CLIMWAT database - Irrigation and Drainage Paper No. 56.				
General Objective 2.0: Know crop coefficients and crop ET to Estimate Crop Evapotranspiration (ETc)						
4-6	2.1 Explain the crop coefficient (Kc) and how it varies across the four main crop growth stages: i. Initial ii. Crop development iii. Mid-season iv. Late-season. 2.2 Distinguish between the single Kc approach and the dual Kc approach ($K_{cb} + K_e$). 2.3 Explain how to calculate crop evapotranspiration ($ET_c = K_c \times ETo$) for	• Describe the crop coefficient (Kc) and how it varies across the four main crop growth stages: - Initial - Crop development - Mid-season - Late-season. Distinguish between the single Kc approach and the dual Kc approach ($K_{cb} + K_e$). • Explain how to calculate crop evapotranspiration	Projector, Slides, White board, Markers Textbooks, Manuals, Multimedia materials	• Build the Kc curve for a selected crop across the four main crop growth stages. • Calculate ETc for selected crop at each growth stage using local Eto. • Repeat for one cereal and one vegetable crop • Tabulate ETc for the season • Compute total seasonal water	Guide students to: • Build the Kc curve for a selected crop across the four main crop growth stages. • Calculate ETc for selected crop at each growth stage using local Eto. • Repeat for one cereal and one vegetable crop • Tabulate ETc for the season	FAO-56 Kc tables Calculators , Worksheet Templates.

	major irrigated crops at each growth stage using standard FAO-56 crop coefficient tables. 2.4 Explain growth stage for common irrigated crops and incorporate this information into seasonal water requirement estimates.	($ET_c = K_c \times ET_o$) for major irrigated crops at each growth stage using standard FAO-56 crop coefficient tables. • Discuss growth stage for common irrigated crops and incorporate this information into seasonal water requirement estimates.		demand.	• Compute total seasonal water demand.	
General Objective 3.0: Understand soil water balance for irrigation water requirement						
7-9	3.1 Explain the field soil water balance equation. 3.2 Distinguish between inputs (rainfall, irrigation) and outputs (evapotranspiration, deep percolation, runoff). 3.3 Describe effective rainfall using standard methods (such as the FAO and USDA approaches) to estimate its contribution to crop water supply. 3.4 Define the Maximum Allowable Depletion	• Describe the field soil water balance equation. • Distinguish between inputs (rainfall, irrigation) and outputs (evapotranspiration, deep percolation, runoff). • Explain effective rainfall using standard methods (such as the FAO and USDA approaches) to estimate its contribution to crop water supply • Explain the Maximum	White board, Markers Textbooks, Manuals, Multimedia materials	• Conduct a daily soil-water balance for 7 days on the demo plot. • Estimate effective rainfall from a recent rainfall event. • Compute the depletion fraction and identify the irrigation date. • Calculate net and gross irrigation depth (assuming a known application efficiency).	Guide students to; • Conduct a daily soil-water balance for 7 days on the demo plot. • Estimate effective rainfall from a recent rainfall event. • Compute the depletion fraction and identify the irrigation date. • Calculate net and gross irrigation depth (assuming a known application	Demo plot, moisture probes, Calculators , Balance templates

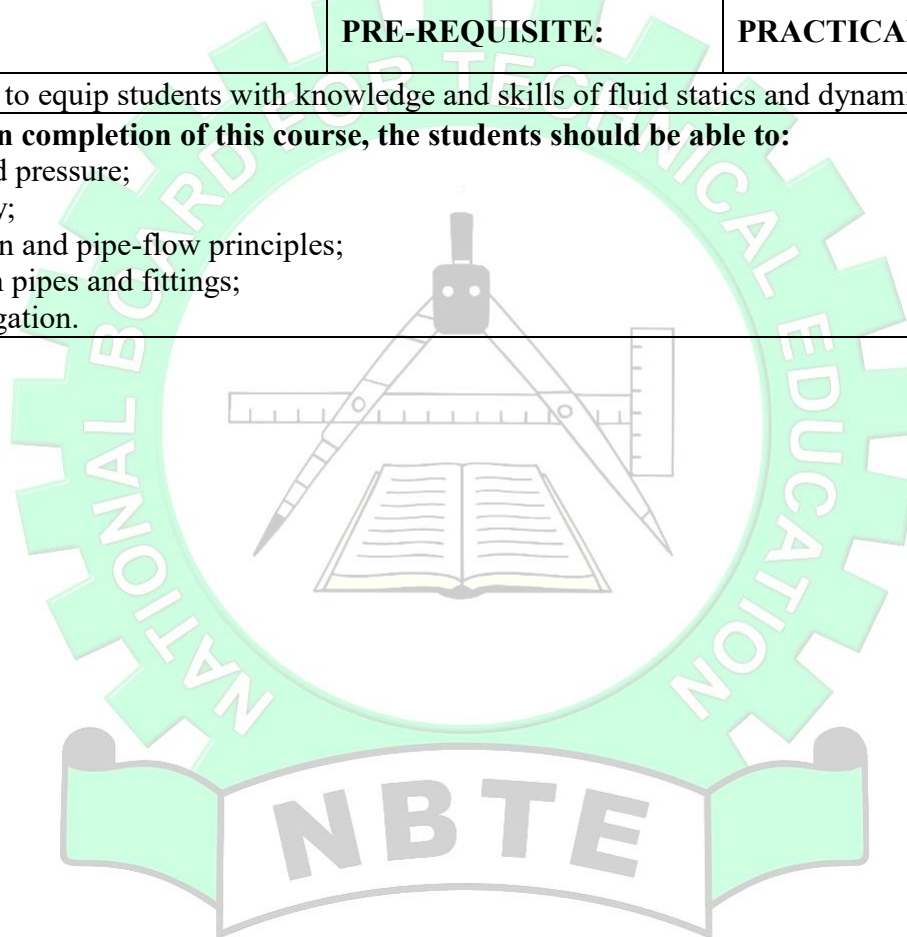
	(MAD) concept and use it to determine appropriate irrigation trigger thresholds for different crops and soil types. 3.5 Describe how to calculate net and gross irrigation depth requirements, accounting for application efficiency and system losses.	Allowable Depletion (MAD) concept and use it to determine appropriate irrigation trigger thresholds for different crops and soil types. • Discuss how to calculate net and gross irrigation depth requirements, accounting for application efficiency and system losses.			efficiency).	
GENERAL OBJECTIVE 4.0: Understand Irrigation scheduling methods						
10-12	4.1 Describe calendar-based irrigation scheduling and discuss its advantages and limitations in field application. 4.2 Explain climate-based irrigation scheduling using calculated ET_c values to determine irrigation timing and depth. 4.3 Describe soil moisture-based scheduling, including the role of tensiometers, gypsum blocks, and other soil moisture sensors in	• Explain calendar-based irrigation scheduling and discuss its advantages and limitations in field application. • Discuss climate-based irrigation scheduling using calculated ET_c values to determine irrigation timing and depth. • Discuss soil moisture-based scheduling, including the role of tensiometers, gypsum blocks, and other soil moisture sensors in guiding irrigation	Projector, Slides, White board, Markers, Textbooks, Manuals, Multimedia materials	• Prepare a fixed-interval irrigation calendar for selected crop. • Prepare a climate-based schedule using daily ET_o and K_c. • Install a soil-moisture sensor on the demo plot and read it daily. • Compare the three schedules in terms of water applied and crop response.	Guide students to: • Prepare a fixed-interval irrigation calendar for selected crop. • Prepare a climate-based schedule using daily ET_o and K_c. • Install a soil-moisture sensor on the demo plot and read it daily. • Compare the three schedules in terms of water applied and crop response.	Calculator Schedule templates, Soil-moisture sensors, Demo plot, monitoring sheets

	guiding irrigation decisions. 4.4 Describe emerging sensor-based and Internet of Things (IoT)-assisted scheduling technologies and explain how they enhance precision irrigation management. 4.5 Explain the merits, limitations, and suitability of each scheduling method in relation to farm scale, data availability, and resource constraints.	decisions. • Explain emerging sensor-based and Internet of Things (IoT)-assisted scheduling technologies and explain how they enhance precision irrigation management. • Discuss the merits, limitations, and suitability of each scheduling method in relation to farm scale, data availability, and resource constraints.				
GENERAL OBJECTIVE 5.0: Understand scheduling support tools and practical application						
13-15	5.1 Explain the use of the FAO CROPWAT software to input climatic and crop data, generate ETo estimates, and produce an irrigation schedule for a selected crop. (introduction), 5.2 Explain the use of mobile and web-based irrigation scheduling tools, assessing their	• Discuss the use of the FAO CROPWAT software to input climatic and crop data, generate ETo estimates, and produce an irrigation schedule for a selected crop. (introduction), • Describe the use of mobile and web-based irrigation scheduling tools, assessing their	Projector, Slides, White board, Markers, Textbooks, Manuals, Multimedia materials	• Run CROPWAT on lab computers; complete one scheduling exercise. • Try one open-source mobile irrigation app on a smartphone. • Develop a full-season irrigation plan for tomato using CROPWAT	Guide students to: • Run CROPWAT on lab computers; complete one scheduling exercise. • Try one open-source mobile irrigation app on a smartphone. • Develop a full-season irrigation plan for tomato	Computers, CROPWAT, Smartphones, Case data, Logbook templates

	accuracy, ease of use, and applicability to smallholder farming conditions. (introduction) 5.3 Explain a complete irrigation schedule for a selected crop over a full growing season, incorporating ETo, ETc, effective rainfall, soil water balance, and MAD principles. (Case Study) 5.4 Explain structured irrigation logbook to document scheduling decisions, irrigation events, weather observations, and field adjustments throughout a crop cycle.	accuracy, ease of use, and applicability to smallholder farming conditions. (introduction) • Discuss a complete irrigation schedule for a selected crop over a full growing season, incorporating ETo, ETc, effective rainfall, soil water balance, and MAD principles. (Case Study) • Discuss structured irrigation logbook to document scheduling decisions, irrigation events, weather observations, and field adjustments throughout a crop cycle.		outputs. • Maintain an irrigation logbook for the demo plot for the rest of the semester.	using CROPWAT outputs. • Maintain an irrigation logbook for the demo plot for the rest of the semester.	
COURSE ASSESSMENT: Coursework: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

FARM HYDRAULICS AND WATER FLOW PRINCIPLES

PROGRAMME: NATIONAL DIPLOMA (ND) IRRIGATION AGRONOMY TECHNOLOGY		
COURSE TITLE: FARM HYDRAULICS AND WATER FLOW PRINCIPLES	COURSE CODE: IAT 115	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 of fluid statics and dynamics relevant to irrigation.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Know fluid properties and pressure; 2.0 Know flow and continuity; 3.0 Know Bernoulli's equation and pipe-flow principles; 4.0 Understand head losses in pipes and fittings; 5.0 Understand pumps in irrigation.		



PROGRAMME: NATIONAL DIPLOMA (ND) IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: FARM HYDRAULICS AND WATER FLOW PRINCIPLES			COURSE CODE: IAT 115		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 of fluid statics and dynamics relevant to irrigation.						
GENERAL OBJECTIVE 1.0: Know fluid properties and pressure						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Define density, specific weight, viscosity and surface tension of water. 1.2 Define pressure and units (kPa, bar, metre of head). 1.3 Describe Pascal's principle and the hydrostatic pressure equation. 1.4 Distinguish absolute vs gauge pressure.	• Explain density, specific weight, viscosity and surface tension of water • Discuss pressure and units (kPa, bar, metre of head) • Explain Pascal's principle and the hydrostatic pressure equation • Distinguish absolute vs gauge pressure	Projector, Slides, White board, Markers Textbooks, Manuals, Multimedia materials	• Measure water density and viscosity in the laboratory • Read pressure on a Bourdon gauge attached to a charged pipe • Measure hydrostatic pressure at three depths in a water column • Convert pressure readings between kPa, bar and m of head	Guide students to: • Measure water density and viscosity in the laboratory • Read pressure on a Bourdon gauge attached to a charged pipe • Measure hydrostatic pressure at three depths in a water column • Convert pressure readings between kPa, bar and m of head	Hydrometer, viscometer, pipes, Calibrated water column, Calculators Bourdon tube pressure gauges Barometers, Simple U-tube Manometer.
General Objective 2.0: Know flow and continuity						
4-6	2.1 Define flow rate (Q) and velocity (V). 2.2 Explain continuity	• Explain flow rate (Q) and velocity (V)	Projector, Slides, White board,	• Measure flow rate from a tap using	• Supervise measurement. • Carryout	Bucket, Stopwatch Pipes of

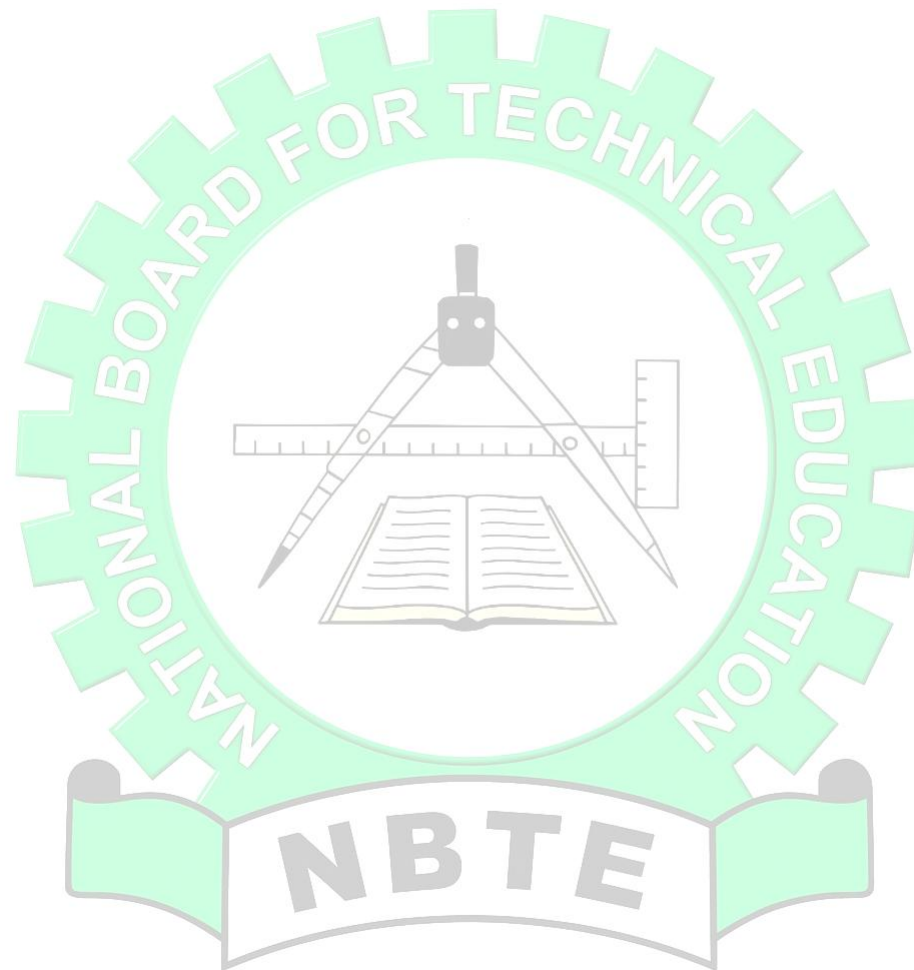
	equation ($Q = A \times V$). 2.3 Distinguish laminar vs turbulent flow (Reynolds number — concept). 2.4 Explain units of flow (L/s, m³/h, lph).	• Discuss continuity equation ($Q = A \times V$) • Distinguish laminar vs turbulent flow (Reynolds number — concept) • Describe units of flow (L/s, m³/h, lph)	Markers Textbooks, Manuals, Multimedia materials	the bucket-and-stopwatch method • Apply continuity to compute velocity in two pipe diameters • Observe laminar and turbulent flow using dye injection • Convert flow values across all common units	continuity application • Conduct dye demonstration. • Carry out unit conversion	different diameters, Dye, Dye injector, Calculator, Hydraulic bench, Open channel fluids Current meters, Flow sensors, E-panet.
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GENERAL OBJECTIVE 3.0: Know Bernoulli's equation and pipe-flow principles

7-9	3.1 State Bernoulli's equation (energy form). 3.2 Explain pressure head, velocity head and elevation head. 3.3 Explain Bernoulli's principles to simple irrigation pipe networks. 3.4 Distinguish total head, static head, and dynamic head.	• Explain Bernoulli's equation (energy form). • Discuss pressure head, velocity head and elevation head. • Describe Bernoulli's principles to simple irrigation pipe networks. • Explain total head, static head, and dynamic head.	Projector, Slides, White board, Markers Textbooks, Manuals, Multimedia materials	• Demonstrate Bernoulli's principle on a Venturi or Pitot-tube apparatus. • Measure pressure head, velocity head and elevation head at three points. • Apply Bernoulli to determine pressure at the outlet of a sprinkler line.	Guide students to: • Demonstrate Bernoulli's principle on a Venturi or Pitot-tube apparatus. • Measure pressure head, velocity head and elevation head at three points. • Apply Bernoulli to determine pressure at the outlet of a sprinkler line.	Venturi or Pitot tube, Manometers, Sprinkler line, Calculators, Recording forms, Bernoulli demo apparatus, Ultrasonic flow meter.
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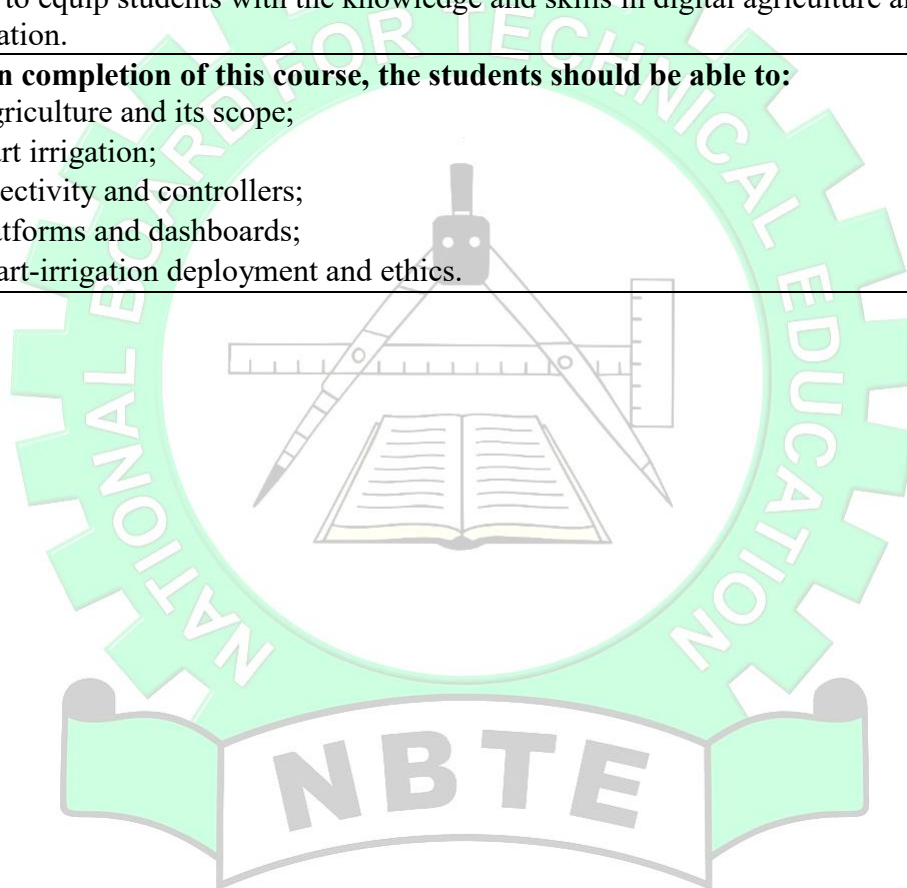
				• Tabulate total / static/dynamic head for one demonstration system.	• Tabulate total / static/dynamic head for one demonstration system.	
General Objective 4.0: Demonstrate head losses in pipes and fittings						
10-12	4.1 Explain major (friction) and minor (fittings) head losses. 4.2 Explain Moody diagrams, Hazen-Williams or Darcy-Weisbach equation (introduction). 4.3 Explain equivalent-length method for fittings. 4.4 Explain total head loss for a simple irrigation lateral.	• Discuss major (friction) and minor (fittings) head losses. • Describe Moody diagrams, Hazen-Williams or Darcy-Weisbach equation (introduction). • Discuss equivalent-length method for fittings. • Describe total head loss for a simple irrigation lateral.	Projector, Slides, White board, Markers Textbooks, Manuals, Multimedia materials	• Measure pressure drops along a 30 m pipe using manometers. • Compute theoretical head loss using Hazen-Williams • Compare with actual figure. • Add a 90-degree elbow and re-measure the additional loss. • Apply the equivalent-length method to estimate elbow loss • Compare to actual figure.	Guide students to: • Measure pressure drops along a 30 m pipe using manometers. • Compute theoretical head loss using Hazen-Williams • Compare with actual figure. • Add a 90-degree elbow and re-measure the additional loss. • Apply the equivalent-length method to estimate elbow loss Compare to actual figure.	Pipe rig, Manometers, Fittings, friction-factor tables, Calculator, Gunt Fluid mechanics equipment, P.A Hilton fluid mechanics bench.
GENERAL OBJECTIVE 5.0: Understand pumps in irrigation						

13-15	5.1 Explain the meaning of pumps (centrifugal, submersible, positive-displacement). 5.2 Describe the classification of pumps (dynamic pumps, positive displacement pumps). 5.3 Explain the 3 types of dynamic pumps (centrifugal, axial and jet pumps). 5.4 State criteria for pump selection. 5.5 Explain the working principle of the pumps above. 5.6 Explain ways of maintaining pumps. 5.4 Describe basic pump-sizing for a small irrigation system.	• Describe the meaning of pumps (centrifugal, submersible, positive-displacement). • Explain the classification of pumps (dynamic pumps, positive displacement pumps). • Discuss the 3 types of dynamic pumps (centrifugal, axial and jet pumps). • Explain criteria for pump selection. • Explain the working principle of the pumps above. • Discuss ways of maintaining pumps. • Describe basic pump-sizing for a small irrigation system.	Projector, Slides, White board, Markers Textbooks, Manuals, Multimedia materials	• Identify each pump type on the demonstration bench. • Operate a centrifugal pump and read head, discharge, and current. • Plot the operating point on a supplied performance curve • Size a pump for a 0.5-ha sprinkler system on the demo farm.	Guide students to: • Identify each pump type on the demonstration bench. • Operate a centrifugal pump and read head, discharge, and current. • Plot the operating point on a supplied performance curve • Size a pump for a 0.5-ha sprinkler system on the demo farm.	Pump Demonstration on bench, Centrifugal pump, Gauges, Ammeter, Performance curves, Calculators, Common replacement parts of the pump, PPEs.
COURSE ASSESSMENT: Coursework: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						



INTRODUCTION TO DIGITAL AGRICULTURE AND SMART IRRIGATION

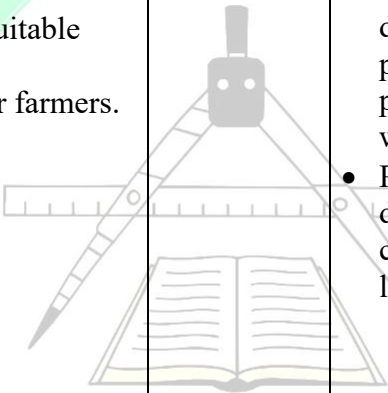
PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY		
COURSE TITLE: INTRODUCTION TO DIGITAL AGRICULTURE AND SMART IRRIGATION	COURSE CODE: IAT 116	CONTACT HOURS: 3 HOURS/WEEK
	CREDIT UNIT: 3	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: I	PRE-REQUISITE:	PRACTICAL: 2 HOURS/WEEK
GOAL: This course is designed to equip students with the knowledge and skills in digital agriculture and smart-irrigation concepts addressing the IoT-enabled irrigation.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand digital agriculture and its scope; 2.0 Know sensors in smart irrigation; 3.0 Understand IoT connectivity and controllers; 4.0 Understand cloud platforms and dashboards; 5.0 Understand basic smart-irrigation deployment and ethics.		

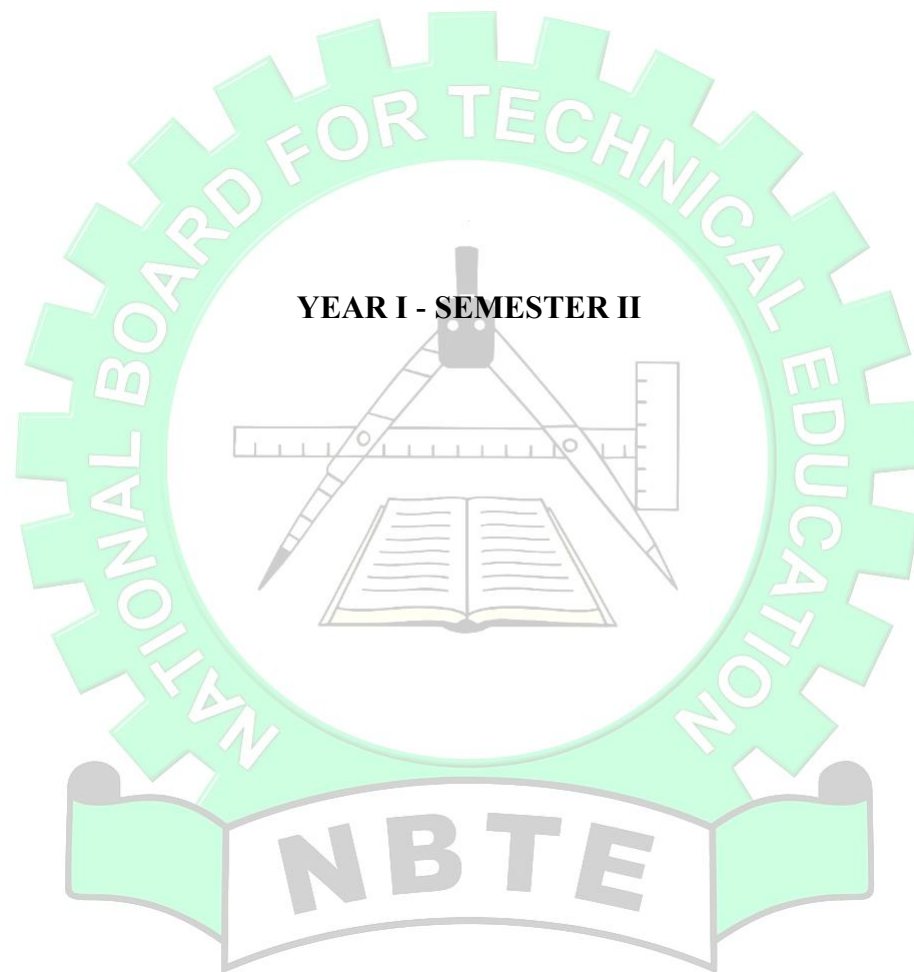


PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: INTRODUCTION TO DIGITAL AGRICULTURE AND SMART IRRIGATION			COURSE CODE: IAT 116		CONTACT HOURS: 3 HOURS/WEEK	
			CREDIT UNIT: 3		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: I			PRE-REQUISITE:		PRACTICAL: 2 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with the knowledge and skills in digital agriculture and smart-irrigation concepts addressing the IoT-enabled irrigation.						
GENERAL OBJECTIVE 1.0: Understand ICT fundamentals and their applications in agriculture						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1-3	1.1 Define digital agriculture, precision agriculture and smart agriculture 1.2 Describe the components of a digital-agriculture stack (sensors, connectivity, platforms, decisions) 1.3 List key Nigerian and international digital-agriculture initiatives 1.4 Explain how digital agriculture supports the Sustainable Development Goals	- Discuss digital agriculture, precision agriculture and smart agriculture - Explain the components of a digital-agriculture stack (sensors, connectivity, platforms, decisions) - Outline key Nigerian and international digital-agriculture initiatives - Discuss how digital agriculture supports the Sustainable Development Goals	Projector, Slides, White board, Markers Textbooks, Manuals, Multimedia materials	- Browse 3 Nigerian agri-tech startup websites - Document their offerings - Sketch a digital-agriculture-stack diagram for a 0.5ha irrigated farm - Tabulate 5 SDGs and explain how digital agriculture contributes to each - Present findings.	Guide students to: - Browse 3 Nigerian agri-tech startup websites - Document their offerings - Sketch a digital-agriculture-stack diagram for a 0.5ha irrigated farm - Tabulate 5 SDGs and explain how digital agriculture contributes to each - Present findings.	Computers with internet, Paper Projection slides Presentation guide
GENERAL OBJECTIVE 2.0: Know sensors in smart irrigation.						

4-6	2.1 Explain the classification of sensors used in irrigation (soil moisture, temperature, humidity, flow, pressure etc.). 2.2 Explain working principles of tensiometers, capacitance and TDR sensors. 2.3 Describe weather-station sensors and their irrigation applications. 2.4 Explain sensor calibration, accuracy and lifespan.	- Describe the classification of sensors used in irrigation (soil moisture, temperature, humidity, flow, pressure etc.). - Describe working principles of tensiometers, capacitance and TDR sensors. - Discuss weather-station sensors and their irrigation applications. - Discuss sensor calibration, accuracy and lifespan.	Projector, Slides, White board, Markers, Textbooks, Manuals, Multimedia materials	- Identify each sensor type on the demonstration bench. - Install a capacitance soil-moisture sensor in the demo plot at 20cm depth. - Calibrate the sensor against the gravimetric method on three samples. - Log sensor readings for 1 week - Plot the moisture curve.	Guide students to: - Identify each sensor type on the demonstration bench. - Install a capacitance soil-moisture sensor in the demo plot at 20cm depth. - Calibrate the sensor against the gravimetric method on three samples. - Log sensor readings for 1 week and - Plot the moisture curve.	Soil moisture sensors (capacitance, TDR tensiometer) Flow sensors Pressure sensors Datalogger Demo plot.
GENERAL OBJECTIVE 3.0: Understand IOT connectivity and controllers						
7-9	3.1 Define IoT and the Internet-of-Agricultural-Things. 3.2 Explain the classification of connectivity options (Wi-Fi, GSM, LoRa, NB-IoT). 3.3 Describe smart-irrigation controllers (ESP32, Arduino, commercial units). 3.4 Explain solenoid	- Explain IoT and the Internet-of-Agricultural-Things. - Discuss the classification of connectivity options (Wi-Fi, GSM, LoRa, NB-IoT). - Explain smart-irrigation controllers (ESP32, Arduino, commercial units). - Describe solenoid	Projector, Slides, White board, Markers, Textbooks, Manuals, Multimedia materials	- Connect an ESP32 / Arduino board to a Wi-Fi network - Send a test message. - Wire a soil-moisture sensor to the controller and read its value. - Wire a relay-driven solenoid valve and	Guide students to: - Connect an ESP32 / Arduino board to a Wi-Fi network - Send a test message. - Wire a soil-moisture sensor to the controller and read its value. - Wire a relay-	ESP32 / Arduino kits Jumper wires Breadboards, Soil-moisture sensors, Relays, Solenoid valves, Laptops.

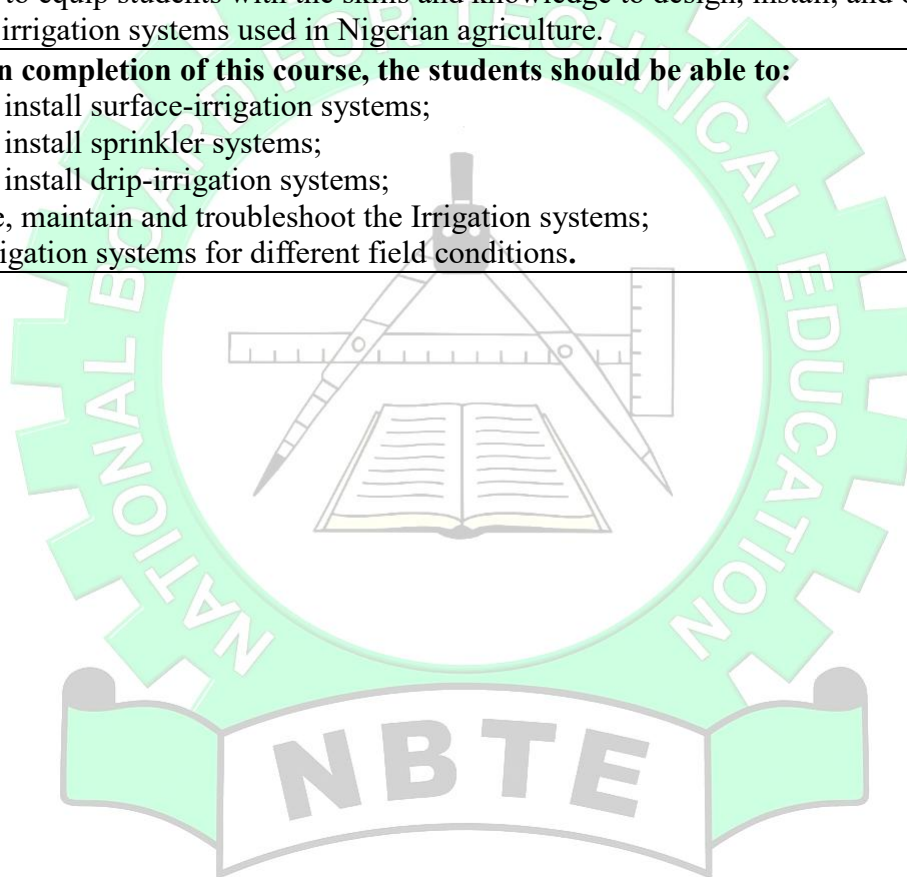
	valves, relays and actuators.	valves, relays and actuators.		• Switch it on/off from code. • Build a simple closed-loop sketch • Irrigate when moisture is less than threshold.	driven solenoid valve and • Switch it on/off from code. • Build a simple closed-loop sketch • Irrigate when moisture is less than threshold.	
GENERAL OBJECTIVE 4.0: Understand cloud platforms and dashboards.						
10-12	4.1 Explain cloud platforms used in agriculture (Things Board, Blynk, Adafruit IO). 4.2 Describe how data flows from sensor → controller → cloud → dashboard. 4.3 Explain a dashboard's elements (widgets, alerts, charts). 4.4 Discuss data security and privacy in smart irrigation.	• Describe cloud platforms used in agriculture (Things Board, Blynk, Adafruit IO). • Explain how data flows from sensor → controller → cloud → dashboard. • Discuss a dashboard's elements (widgets, alerts, charts). • Explain data security and privacy in smart irrigation.	Projector, Slides, White board, Markers, Textbooks, Manuals, Multimedia materials	• Create a free account on one IoT cloud platform. • Send soil-moisture data from the ESP32 to the cloud platform. • Build a dashboard showing real-time moisture and a control switch. • Configure an alert that sends a notification when moisture is less than the threshold.	Guide students to: • Create a free account on one IoT cloud platform. • Send soil-moisture data from the ESP32 to the cloud platform. • Build a dashboard showing real-time moisture and a control switch. • Configure an alert that sends a notification when moisture is less than the threshold.	IoT cloud platform accounts, Computers, ESP32 kits, Internet connection.
GENERAL OBJECTIVE 5.0: Understand basic smart-irrigation deployment and ethics						

13-15	5.1 Explain how to plan a basic smart-irrigation deployment for a 0.5 ha plot. 5.2 Outline costs, components and skills needed. 5.3 Explain the benefits, risks and ethical considerations of digital agriculture. 5.4 Describe equitable access for smallholder farmers.	- Describe how to plan a basic smart-irrigation deployment for a 0.5 ha plot. - Discuss costs, components and skills needed. - Explain the benefits, risks and ethical considerations of digital agriculture. - Explain equitable access for smallholder farmers.	Projector, Slides, White board, Markers, Textbooks, Manuals, Multimedia materials 	- Produce a list and cost estimate for a 0.5 ha smart-irrigation system. - Run a complete smart-irrigation demo (sensor + controller + valve + dashboard) on the field. - Document the deployment process in a 4-page field report with photos. - Present the deployment to the class and discuss limitations.	Guidestudents to: - Produce a list and cost estimate for a 0.5 ha smart-irrigation system. - Run a complete smart-irrigation demo (sensor + controller + valve + dashboard) on the field. - Document the deployment process in a 4-page field report with photos. - Present the deployment to the class and discuss limitations.	Catalogues Full smart-irrigation kit Demonstration plots Cameras Presentation slides BoQ templates.
COURSE ASSESSMENT: Coursework: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

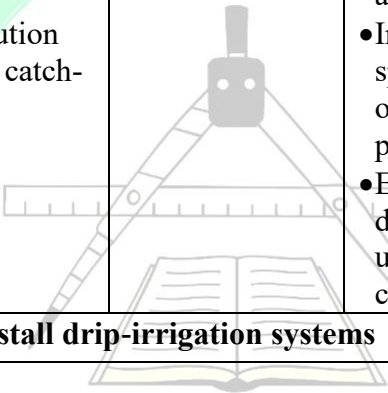


SURFACE, SPRINKLER AND DRIP IRRIGATION SYSTEMS

PROGRAMME: NATIONAL DIPLOMA (ND) IRRIGATION AGRONOMY TECHNOLOGY		
COURSE TITLE: SURFACE, SPRINKLER AND DRIP IRRIGATION SYSTEMS	COURSE CODE: IAT 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 the skills and knowledge to design, install, and operate the three main pressurised and non-pressurised irrigation systems used in Nigerian agriculture.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Know the layout and install surface-irrigation systems; 2.0 Know the layout and install sprinkler systems; 3.0 Know the layout and install drip-irrigation systems; 4.0 Know how to operate, maintain and troubleshoot the Irrigation systems; 5.0 Know appropriate irrigation systems for different field conditions.		



PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: SURFACE, SPRINKLER AND DRIP IRRIGATION SYSTEMS			COURSE CODE: IAT 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 the skills and knowledge to design, install, and operate the three main pressurised and non-pressurised irrigation systems used in Nigerian agriculture.						
GENERAL OBJECTIVE 1.0: Know the layout and install surface-irrigation 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 parameters for basin irrigation (size, depth). 1.2 Describe parameters for border irrigation (length, slope, stream size). 1.3 Explain parameters for furrow irrigation (length, spacing, stream size). 1.4 Explain field-evaluation methods (Christiansen-style uniformity).	- Describe the layout and installation of basin irrigation systems. - Explain the layout and installation of border irrigation systems. - Describe the layout and installation of furrow irrigation systems. - Discuss methods for evaluating the performance of surface irrigation systems.	Projector, Slides, White board, Markers Textbooks, Manuals, Multimedia materials	- Demonstrate the layout and construction of basin and border plots on the demonstration field - Demonstrate Layout furrows for a row crop and running water through them - Measure advance and recession times along a furrow - Calculate distribution uniformity and	Guide students to: - Demonstrate the layout and construction of basin and border plots on the demonstration field - Demonstrate Layout furrows for a row crop and running water through them - Measure advance and recession times along a furrow - Calculate distribution uniformity and application efficiency	Demo plot, Surveying tools, Ridger, Water source, s Stopwatches, Recording sheets.

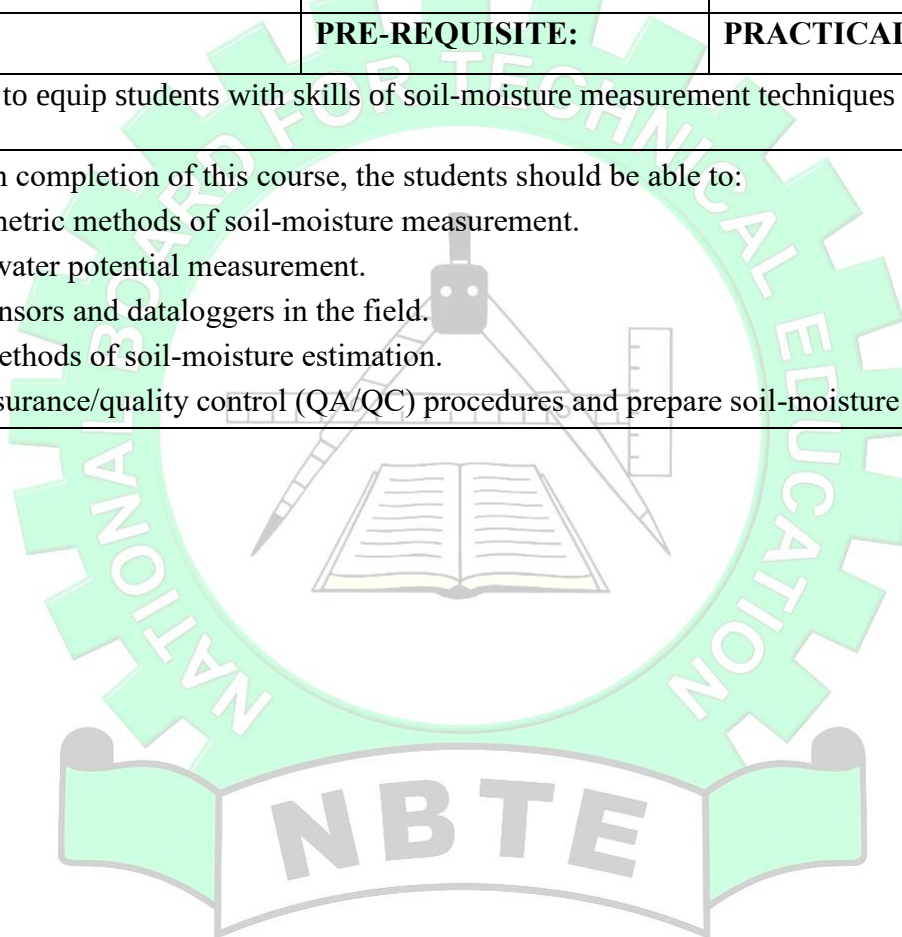
				application efficiency		
General Objective 2.0: Know lay out and install sprinkler systems						
4-6	2.1 Explain sprinkler spacing, application rate and operating pressure. 2.2 Explain the sprinkler-selection process using catalogues. 2.3 Explain mainline and lateral sizing. 2.4 Explain distribution uniformity from catch-can data.	• Explain sprinkler spacing, application rate and operating pressure. • Discuss the sprinkler-selection process using catalogues. • Explain mainline and lateral sizing. • Describe distribution uniformity from catch-can data.	Projector, Slides, White board, Markers Textbooks, Manuals, Multimedia materials 	• Select sprinklers • Design a layout for a 0.25-ha plot. • Size the mainline and laterals; produce a parts list. • Install the sprinkler system on the demo plot. • Evaluate distribution uniformity using catch cans.	Guide students to: • Select sprinklers • Design a layout for a 0.25-ha plot. • Size the mainline and laterals; produce a parts list. • Install the sprinkler system on the demo plot. • Evaluate distribution uniformity using catch cans.	Sprinkler kit, Pipes, Fittings, Catch cans, Calculators, Parts-list templates
General Objective 3.0: Know the layout and install drip-irrigation systems						

7-9	3.1 Explain how to compute drip system flow, pressure and emitter discharge. 3.2 Explain emitter selection (online, inline, micro-jet). 3.3 Explain filtration selection (screen, disc, sand). 3.4 Explain layout for row crops and orchards.	• Explain how to compute drip system flow, pressure and emitter discharge. • Explain emitter selection (online, inline, micro-jet). • Explain filtration selection (screen, disc, sand). • Explain layout for row crops and orchards.	Projector, Slides, White board, Markers Textbooks, Manuals, Multimedia materials	• Design a drip layout for a 0.25-ha row-crop plot • Size the filter, mainline, sub-mains, laterals and emitter spacing. • Install the drip system on the demonstration field. • Measure emitter discharge and compute application uniformity.	Guide students to: • Design a drip layout for a 0.25-ha row-crop plot • Size the filter, mainline, sub-mains, laterals and emitter spacing. • Install the drip system on the demonstration field. • Measure emitter discharge and compute application uniformity.	Drip kit, Filters, Emitters, Pipes, Water source, Measuring containers, Calculators.
General Objective 4.0: Know how to operate, maintain and troubleshoot the irrigation systems						
10-12	4.1 Define start-up, run and shut-down procedures. 4.2 Outline common operational problems (clogging, blowouts, leaks). 4.3 Explain corrective actions. 4.4 Explain how to maintain a system-operation logbook.	• Explain start-up, run and shut-down procedures. ○ Discuss common operational problems (clogging, blowouts, leaks). ○ Discuss corrective actions. • Explain how to maintain a system-operation logbook.	Projector, Slides, White board, Markers Textbooks, Manuals, Multimedia materials	• Operate each system through a full start-up, run and shut-down cycle. • Diagnose 3 deliberate faults (clogged emitter, leaking joint, pressure drop). • Apply corrective actions to restore normal operation. • Maintain a daily	Guide students to: • Operate each system through a full start-up, run and shut-down cycle. • Diagnose 3 deliberate faults (clogged emitter, leaking joint, pressure drop). • Apply corrective actions to restore normal operation. Maintain a daily logbook for 2 weeks of operation.	Demo systems, Repair tools, Fault scenarios, Logbook templates.

				logbook for 2 weeks of operation.		
GENERAL OBJECTIVE 5.0: Know appropriate irrigation systems for different field conditions						
13-15	5.1 Discuss cost comparison. 5.2 Explain the difference in water-use efficiency, labour need and crop suitability. 5.3 Explain decision matrix to select the best system for a case.	• Discuss cost comparison. • Explain the difference in water-use efficiency, labour need and crop suitability. • Explain decision matrix to select the best system for a case.	Projector, Slides, White board, Markers, Textbooks, Manuals, Multimedia materials	• Compute installation and operating cost per ha for each system. • Tabulate efficiency, labour and crop-fit data from class experiments. • Apply decision matrix to 3 farm scenarios and recommend a system. • Compile and submit a 4-page comparative report.	Guide students to: • Compute installation and operating cost per ha for each system. • Tabulate efficiency, labour and crop-fit data from class experiments. • Apply decision matrix to 3 farm scenarios and recommend a system. • Compile a 4-page comparative report.	Cost data, Calculators, Decision-matrix templates, Report templates Etc.
COURSE ASSESSMENT: Coursework: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

SOIL MOISTURE MEASUREMENT AND FIELD TECHNIQUES

PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY		
COURSE TITLE: SOIL MOISTURE MEASUREMENT AND FIELD TECHNIQUES	COURSE CODE: IAT 122	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL:
YEAR: I SEMESTER: II	PRE-REQUISITE:	PRACTICAL: 4 HOURS/WEEK
GOAL: This course is designed to equip students with skills of soil-moisture measurement techniques used in modern irrigation farming.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Apply gravimetric and volumetric methods of soil-moisture measurement. 2.0 Apply tensiometers for soil-water potential measurement. 3.0 Apply electronic moisture sensors and dataloggers in the field. 4.0 Apply remote and indirect methods of soil-moisture estimation. 5.0 Apply calibration, quality assurance/quality control (QA/QC) procedures and prepare soil-moisture monitoring reports.		



PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: SOIL MOISTURE MEASUREMENT AND FIELD TECHNIQUES			COURSE CODE: IAT 122		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNIT: 4		THEORETICAL:	
YEAR: I SEMESTER: II			PRE-REQUISITE:		PRACTICAL: 4 HOUR/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with skills of soil-moisture measurement techniques used in modern irrigation farming.						
GENERAL OBJECTIVE 1.0: Apply gravimetric and volumetric methods of soil-moisture measurement						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1 – 3				- Collect soil samples at 0–20 cm and 20–40 cm depths from 5 locations on the demo plot using a soil auger - Weigh fresh soil samples, oven-dry at 105 °C for 24 hours, and reweigh to determine gravimetric water content. - Collect undisturbed core samples using a core sampler and determine bulk density. - Convert gravimetric water content to volumetric water content using bulk density values. - Tabulate all results,	Guide students to: - Collect soil samples at 0–20 cm and 20–40 cm depths from 5 locations on the demo plot using a soil auger - Weigh fresh soil samples, oven-dry at 105 °C for 24 hours, and reweigh to determine gravimetric water content. - Collect undisturbed core samples using a core sampler and determine bulk density. - Convert gravimetric water content to	Soil augers, Core sampler, Oven, analytical balance, Sample tins, Desiccator, Calculators, Field data sheets, Graph paper, GPS

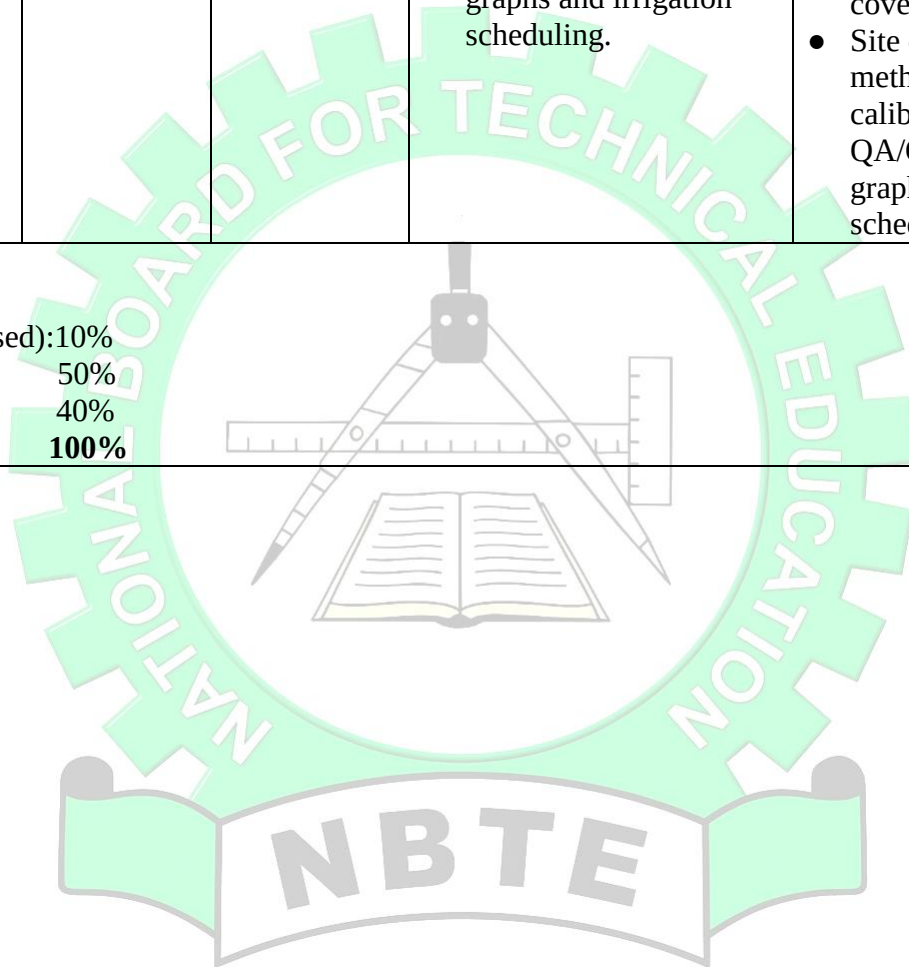
				- Plot a moisture-depth profile - Interpret the findings for irrigation scheduling	volumetric water content using bulk density values. - Tabulate all results, - Plot a moisture-depth profile - Interpret the findings for irrigation scheduling	
GENERAL OBJECTIVE 2.0: Apply tensiometers for soil-water potential measurement						
4-6				- Install a tensiometer correctly in the field for soil water potential measurement. - Measure soil water potential using a tensiometer. - Record the reading - Interpret tensiometer readings for irrigation scheduling. - Perform routine maintenance of a tensiometer.	Guide students to: - Install a tensiometer correctly in the field for soil water potential measurement. - Measure soil water potential using a tensiometer. - Record the reading - Interpret tensiometer readings for irrigation scheduling. - Perform routine maintenance of a tensiometer.	Tensiometer , Soil auger, Field plot, water container. Installed tensiometer, Data recording sheet.
General Objective 3.0: Apply electronic moisture sensors and dataloggers in the field.						
7-9		.		Install capacitance/FDR sensors at two depths and read values using a	Guide students to: Install capacitance/FDR	Capacitance/FDR sensors,

				handheld meter. ● Install Watermark (gypsum block) sensors at the same depths and read with a dedicated reader. ● Install TDR probes and record readings on the same plot. ● Compare simultaneous readings from all three sensor types at the same location and tabulate differences. ● Connect a capacitance sensor to a datalogger, configure logging interval to 30 minutes and log readings for one week. ● Download logger data to a computer, plot a time-series graph and identify any anomalies	sensors at two depths and read values using a handheld meter. ● Install Watermark (gypsum block) sensors at the same depths and read with a dedicated reader. ● Install TDR probes and record readings on the same plot. ● Compare simultaneous readings from all three sensor types at the same location and tabulate differences. ● Connect a capacitance sensor to a datalogger, configure logging interval to 30 minutes and log readings for one week. ● Download logger data to a computer, plot a time-series graph and identify any anomalies	TDR probes, Watermark/ gypsum blocks, Handheld readers, Logger data, Laptop with logger data software, Installation tools, Demo plot, Data sheets, GPS, Eetc.
General Objectives 4.0: Apply remote and indirect methods of soil-moisture estimation						

10-12				• Apply the look-and-feel hand method on soil samples from 0–10 cm, 10–20 cm and 20–40 cm depths • Estimate moisture class for each. • Measure canopy temperature of an irrigated and a water-stressed • Plot using an infrared thermometer. • Calculate the Crop Water Stress Index (CWSI) from canopy • Read air temperature. • Access a satellite-derived soil-moisture map (SMAP or equivalent) for the local region • Identify moisture zones. • Compare look-and-feel estimates, sensor readings • Estimates satellite for the same field. • Tabulate accuracy differences. • Show the strengths and limitations of each indirect method in a	Guide students to: • Apply the look-and-feel hand method on soil samples from 0–10 cm, 10–20 cm and 20–40 cm depths • Estimate moisture class for each. • Measure canopy temperature of an irrigated and a water-stressed • Plot using an infrared thermometer. • Calculate the Crop Water Stress Index (CWSI) from canopy • Read air temperature. • Access a satellite-derived soil-moisture map (SMAP or equivalent) for the local region • Identify moisture zones. • Compare look-and-feel estimates, sensor readings and satellite estimates for the same field.	IR thermometer , Soil samples from three depths, Psychrometer or weather station (air temperature) , Internet-enabled computer, Satellite soil-moisture map URL, Field report template, Demo plot, GPS.
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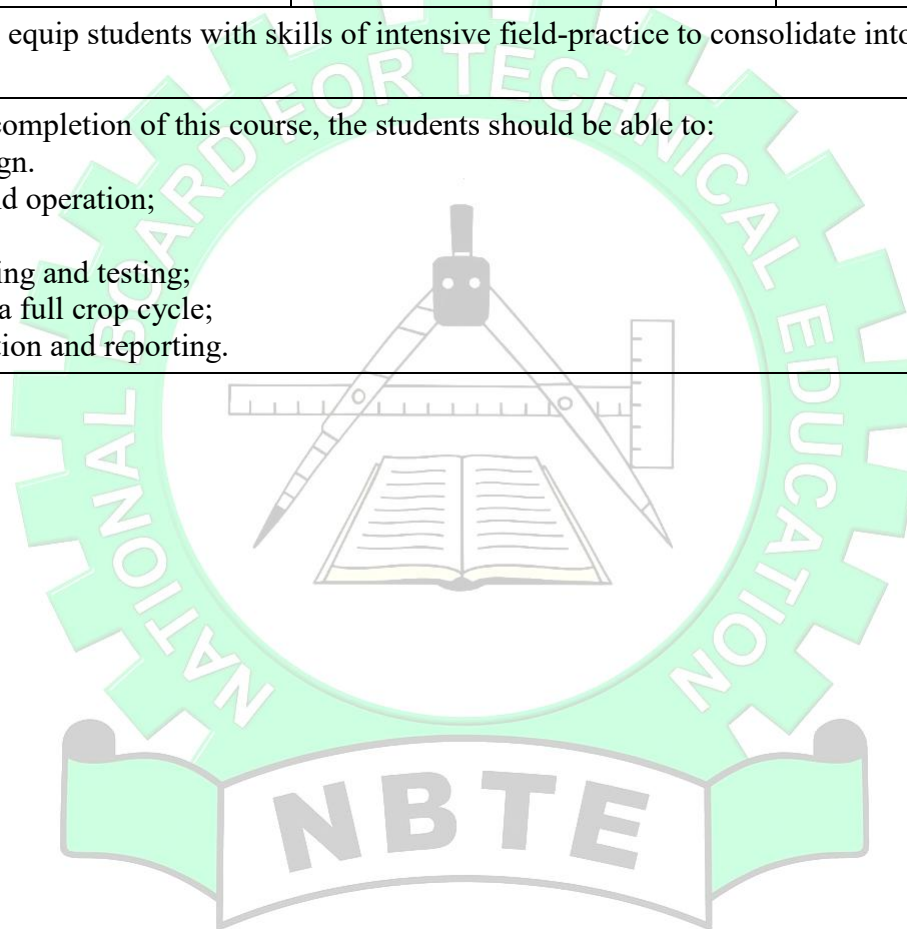
				written field report.	• Tabulate accuracy differences. • Show the strengths and limitations of each indirect method in a written field report.	
General objectives 5.0: Apply calibration, quality assurance/quality control QA/QC procedures and prepare soil-moisture monitoring reports						
13-15				• Calibrate one capacitance sensor against gravimetric reference samples at 5 moisture levels • Plot a calibration curve. • Apply the calibration equation to adjust raw sensor outputs and quantify the improvement in accuracy. • Apply (QA/QC) checks on a supplied 2-week datalogger dataset • Check for missing values, range violations and drift. • Identify, flag and remove outliers from the datalogger records using agreed threshold criteria. • Produce a complete 4-page soil-moisture monitoring report	• Guide students to: • Calibrate one capacitance sensor against gravimetric reference samples at 5 moisture levels • Plot a calibration curve. • Apply the calibration equation to adjust raw sensor outputs and quantify the improvement in accuracy. • Apply (QA/QC) checks on a supplied 2-week datalogger dataset • Check for missing values, range violations and drift. • Identify, flag and remove outliers from the datalogger records using agreed	Capacitance sensor, Oven, Analytical balance, Sample tins, Laptop with datalogger software, Supplied 2-week dataset, Graph paper or spreadsheet, Report template, Printer, GPS.

				covering • Site description, methods used, calibrated data, QA/QC summary, graphs and irrigation scheduling.	threshold criteria. • Produce a complete 4-page soil-moisture monitoring report covering: • Site description, methods used, calibrated data, QA/QC summary, graphs and irrigation scheduling.	
COURSE ASSESSMENT: Course Assessment Course Assessment (Practical Based):10% Practical: 50% Examination (Practical Based): 40% Total: 100%						



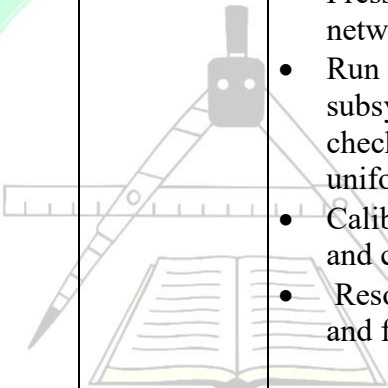
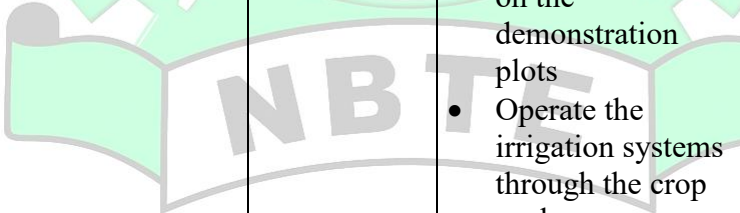
PRACTICAL IRRIGATION INSTALLATION AND FIELD OPERATIONS I

COURSE TITLE: PRACTICAL IRRIGATION INSTALLATION AND FIELD OPERATIONS I	COURSE CODE: IAT 123	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 0
YEAR: I SEMESTER: II	PRE-REQUISITE: NIL	PRACTICAL: 4 HOURS/WEEK
GOAL: This course is designed to equip students with skills of intensive field-practice to consolidate into a full installation and operating cycle on the demonstration field.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Know Site survey and design. 2.0 Know Pump installation and operation; 2.0 Know System installation; 3.0 Know System commissioning and testing; 4.0 Know Field operations for a full crop cycle; 5.0 Know Performance evaluation and reporting.		



PROGRAMME: NATIONAL DIPLOMA (ND) IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: PRACTICAL IRRIGATION INSTALLATION AND FIELD OPERATIONS I			COURSE CODE: IAT 123		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNIT: 4		THEORETICAL: 0	
YEAR: I SEMESTER: II			PRE-REQUISITE: Nil		PRACTICAL: 4 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with skills of intensive field-practice to consolidate into a full installation and operating cycle on the demonstration field.						
GENERAL OBJECTIVE 1.0: Know Site survey and design						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3				•Conduct a site survey of the demonstration field (slope, soil, water source) •Lay out the area for a multi-method irrigation installation •Prepare a Bill of Quantities and procurement list •Submit a complete Layout design package	Guide students to: •Conduct a site survey of the demonstration field (slope, soil, water source) •Lay out the area for a multi-method irrigation installation •Prepare a Bill of Quantities and procurement list •Submit a complete Layout design package	Surveying tools, Pegs, Design templates, BoQ templates, Demo field.
GENERAL OBJECTIVE 2.0: Know Pump installation and operation						
				•Select appropriate pumps for irrigation	Guide students to: • Select appropriate	Centrifugal irrigation pump

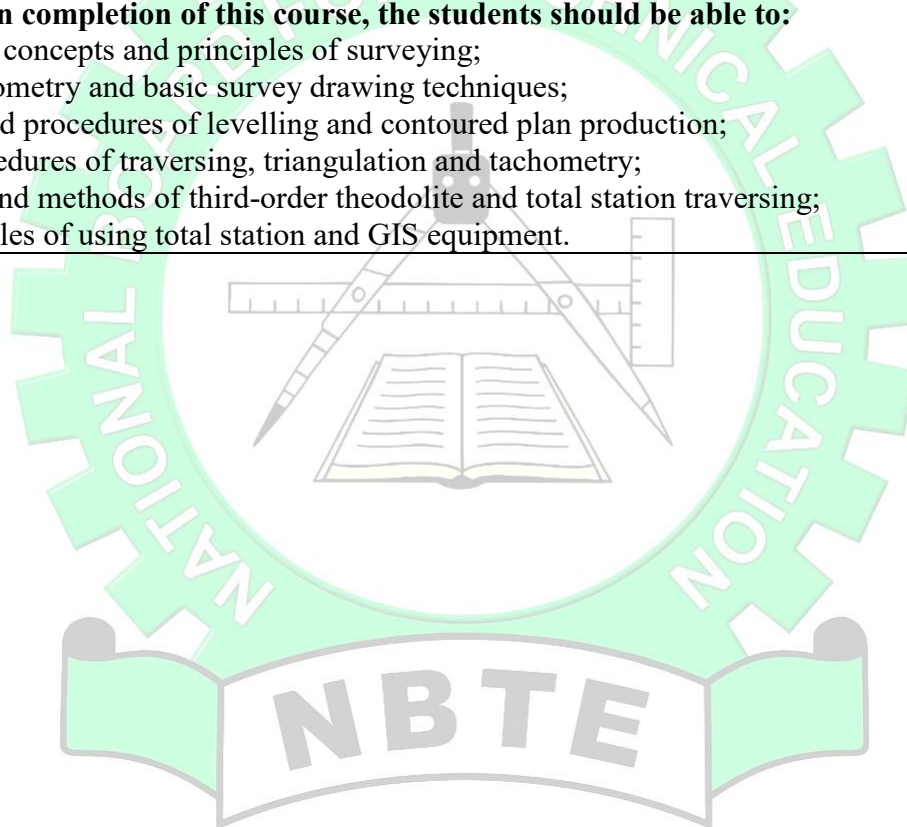
			systems. • Identify major pump components and their functions. • Install irrigation pumps correctly. • Operate pumps safely and efficiently. • Assemble pump units. • Dismantle pump units. • Prime centrifugal pumps before operation. • Measure pump discharge and pressure. • Diagnose common pump problems.	pumps for irrigation systems. • Identify major pump components and their functions. • Install irrigation pumps correctly. • Operate pumps safely and efficiently. • Assemble pump units. • Dismantle pump units. • Prime centrifugal pumps before operation. • Measure pump discharge and pressure. • Diagnose common pump problems.	Submersible pump Solar water pump (if available) Electric motor Diesel engine pump set Water storage tank
GENERAL OBJECTIVE 3.0: Know System installation					
9-10			• Install surface-irrigation infrastructure (channels, gates). • Install a sprinkler subsystem (pump, mainline, laterals, and sprinklers). • Install a drip subsystem (filter,	Guide students to: • Install surface-irrigation infrastructure (channels, gates). • Install a sprinkler subsystem (pump, mainline, laterals, and sprinklers). • Install a drip	Complete kits for surface, Sprinkler, Drip and smart subsystems, Demo field.

				mainline, sub-mains, laterals, emitters) • Install a smart-irrigation subsystem (sensors, controller, valves).	subsystem (filter, mainline, sub-mains, laterals, emitters) • Install a smart-irrigation subsystem (sensors, controller, valves).	
GENERAL OBJECTIVE 4.0: Know System commissioning and testing						
11-12				• Pressure-test the network • Run each subsystem and check distribution uniformity • Calibrate sensors and controllers • Resolve all leaks and faults	Guide students to: • Pressure-test the network • Run each subsystem and check distribution uniformity • Calibrate sensors and controllers • Resolve all leaks and faults	Pressure gauges, Catch cans, Calibration kit, Repair tools, Fault logs Etc.
GENERAL OBJECTIVE 5.0: Know Field operations for a full crop cycle						
12-13				• Establish a crop on the demonstration plots • Operate the irrigation systems through the crop cycle • Apply maintenance and troubleshooting as	Guide students to: • Establish a crop on the demonstration plots • Operate the irrigation systems through the crop cycle • Apply maintenance and troubleshooting as needed	Seedlings, Fertilisers, Monitoring sheets, Demo field

				needed • Record water applied, growth and yield	• Record water applied, growth and yield	
GENERAL OBJECTIVE 6.0: Performance evaluation and reporting						
14-15				• Compute water-use efficiency and uniformity for each subsystem • Compare yield across subsystems • Identify lessons learned • Submit a 10-page final field-operations report	Guide students to: • Compute water-use efficiency and uniformity for each subsystem • Compare yield across subsystems • Identify lessons learned • Submit a 10-page final field-operations report	Calculators, Yield data, Report templates.
COURSE ASSESSMENT: Course Assessment Course Assessment (Practical Based):10% Practical: 50% Examination (Practical Based): 40% Total: 100%						

BASIC PRINCIPLES OF IRRIGATION SURVEYING

PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY		
COURSE TITLE: BASIC PRINCIPLES OF IRRIGATION SURVEYING	COURSE CODE: IAT 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 of irrigation surveying to map the topography and boundaries of agricultural lands design, construct and manage efficient water distribution system.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the fundamental concepts and principles of surveying; 2.0 Appreciate surveying trigonometry and basic survey drawing techniques; 3.0 Understand the principles and procedures of levelling and contoured plan production; 4.0 Know the methods and procedures of traversing, triangulation and tachometry; 5.0 Understand the procedures and methods of third-order theodolite and total station traversing; 6.0 Understand the basic principles of using total station and GIS equipment.		



PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: BASIC PRINCIPLES OF IRRIGATION SURVEYING			COURSE CODE: IAT 124		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 practical skills of irrigation surveying to map the topography and boundaries of agricultural lands design, construct and manage efficient water distribution system.						
GENERAL OBJECTIVE 1.0: Understand the fundamental concepts and principles of surveying						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-2	1.1 Define Surveying. 1.2 Distinguish between the following major divisions of surveying: (i) Geodetic surveying (ii) Plane surveying. 1.3 State the uses of plane surveying (e.g. maps and plans, geographical, geological engineering, military purpose etc.). 1.4 Explain the three stages of surveying process. (i) Reconnaissance (ii) Observation and measurement (iii) Presentation. 1.5 Illustrate the basic principles of surveying measurements (linear and angular). 1.6 State the branches of surveying in mineral	• Explain Surveying. • Explain the difference between the following major divisions of surveying: - Geodetic surveying - Plane surveying • Outline the uses of plane surveying (e.g. maps and plans, geographical, geological engineering, military purpose etc.). • Discuss the three stages of surveying process. - Reconnaissance - Observation and measurement - Presentation • Explain the basic principles of	Textbooks, E-books, Lecture notes, Whiteboard, PowerPoint Projector, Screen,	•Identify different survey instruments and maps conventions. •Name common survey instruments in the laboratory. •Identify standard map conventions and symbols on a topographic map. •Carry out a reconnaissance walk of a demonstration plot •Sketch a field boundary. •Record field observations in a standard survey field book.	Guide students to: •Identify different survey instruments and maps conventions. •Name common survey instruments in the laboratory. •Identify standard map conventions and symbols on a topographic map. •Carry out a	Pegs, Chains, Tapes, Ranging poles, GPS, GIS Paper Drawing tables Maps, Demo plot, Chain, Tape, Ranging poles.

	exploration and exploitation.	surveying measurements (linear and angular). • Outline the branches of surveying in mineral exploration and exploitation.			reconnaissance walk of a demonstration plot • Sketch a field boundary. • Record field observations in a standard survey field book.	
GENERAL OBJECTIVE 2.0: Appreciate surveying trigonometry and basic survey drawing techniques.						
3-5	2.1 Explain the trigonometric ratios of common angles used in surveying. 2.2 Explain the sine rule, cosine rule and Napier's tangent rule to solve triangle problems. 2.3 Explain how to calculate the area of triangles using trigonometric methods. 2.4 Explain the use of scales and their application in survey drawings. 2.5 Describe the correct handling and use of drawing instruments: compasses, dividers,	• Discuss the trigonometric ratios of common angles used in surveying. • Explain the sine rule, cosine rule and Napier's tangent rule to solve triangle problems. • Discuss how to calculate the area of triangles using trigonometric methods. • Explain the use of scales and their application in survey drawings. • Discuss the correct handling and use of drawing instruments: compasses, dividers,	Textbooks, E-books, Lecture notes, Whiteboard, PowerPoint Projector, Screen,	• Solve 5 triangle problems using the sine rule, cosine rule and Napier tangent rules. • Calculate areas of triangular Plots from field data using trigonometric methods. Identify and correctly use all drawing instruments in a drawing set. • Produce a simple scaled survey plan using correct lettering and ink-drawing technique.	Guide students on: • Solving trigonometry. • Area calculations from field data. • Drawing instrument handling. • Review and mark student scaled drawings.	Scientific calculators, Drawing sets, Drawing boards, Drawing paper, Practical manual.

	protractors, set squares and pencils. 2.6 Describe basic ink-drawing and lettering techniques used in survey plans.	protractors, set squares and pencils. • Explain basic ink-drawing and lettering techniques used in survey plans.				
GENERAL OBJECTIVE 3.0: Understand the principles and procedures of levelling and contoured plan production						
6-8	3.1 Define levelling. 3.2 State its importance in irrigation channel design. 3.3 Explain levelling terms: datum, level surface, line of collimation, mean sea level and bench mark. 3.4 Describe the basic principle of levelling. 3.5 Explain levelling procedures: compound levelling, flying level, profile levelling and reciprocal levelling. 3.6 Explain how to reduce levelling results using the rise-and-fall method and the height-of-collimation method. 3.7 Describe the effects of curvature and atmospheric refraction on levelling. 3.8 State typical instrumental, natural	• Explain levelling. • Outline its importance in irrigation channel design. • Describe levelling terms: datum, level surface, line of collimation, mean sea level and bench mark. • Discuss the basic principle of levelling. • Explain levelling procedures: compound levelling, flying level, profile levelling and reciprocal levelling. • Discuss how to reduce levelling results using the rise-and-fall method and the height-of-collimation method. • Explain the effects of curvature and atmospheric refraction on levelling.	Textbooks, E-books, Lecture notes, Whiteboard, PowerPoint Projector, Flip charts	• Set up an automatic level on the demonstration field. • Carry out flying levels along a 200 m line • Record results in a field book. • Carry out levelling reduction using both the rise-and-fall method and the height-of-collimation method on a given field dataset. • Examine a provided set of levelling field notes. • Detect any existing mistakes or discrepancies, • Apply appropriate corrections to	Guide students to: • Set up an automatic level on the demonstration field. • Carry out flying levels along a 200 m line • Record results in a field book. • Carry out levelling reduction using both the rise-and-fall method and the height-of-collimation method on a given field dataset. • Examine a provided set of	Practical manuals. Drawing set, Drawing board, Drawing paper.

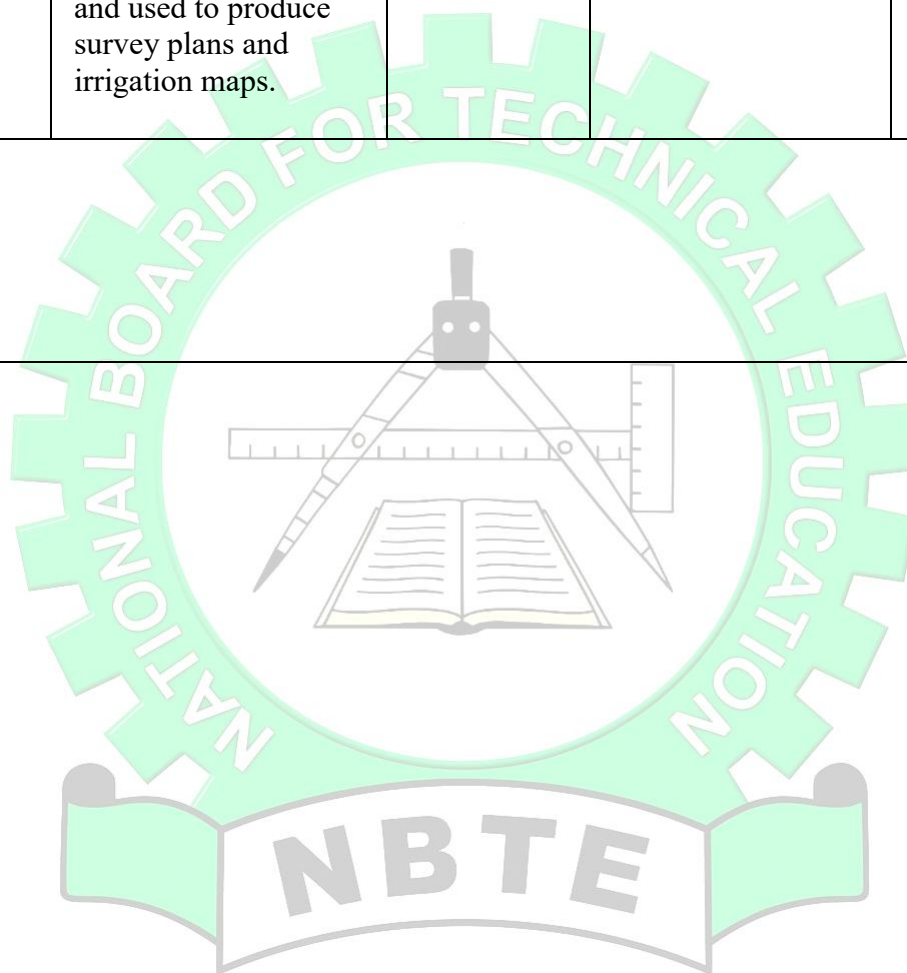
	and personal errors in levelling. 3.9 Explain the need for spot heights in topographical and engineering surveys. 3.10 Describe optimum distribution of spot heights and use of grids of levels for contoured plans. 3.11 Explain the procedure for contouring at 0.5 m vertical interval from a mesh of spot heights.	• Outline typical instrumental, natural and personal errors in levelling. • Describe the need for spot heights in topographical and engineering surveys. • Explain optimum distribution of spot heights and use of grids of levels for contoured plans. • Discuss the procedure for contouring at 0.5 m vertical interval from a mesh of spot heights.		obtain consistent and acceptable reduced levels. • Conduct a grid-levelling exercise • Record spot heights at 10 m intervals. • Plot contours at 0.5 m vertical interval from the spot-height grid.	levelling field notes, • Detect any existing mistakes or discrepancies. • Apply appropriate corrections to obtain consistent and acceptable reduced levels. • Conduct a grid-levelling exercise and • Record spot heights at 10 m intervals. • Plot contours at 0.5 m vertical interval from the spot-height grid.	
GENERAL OBJECTIVE 4.0: Know the methods and procedures of traversing, triangulation and tachometry						
9-11	4.1 Define traversing. 4.2 Explain traversing principles. 4.3 Explain the Bowditch and transit methods of adjustment of closed traverses. 4.4 Describe calculations of bearings, distances and coordinates from	• Explain traversing. • Discuss traversing principles. • Discuss the Bowditch and transit methods of adjustment of closed traverses. • Explain calculations of bearings, distances	Textbooks, E-books, Lecture notes, Whiteboard, PowerPoint Projector, Screen,	• Carry out a closed compass traverse of a designated area and • Adjust using the Bowditch method. • Calculate bearings, distances • Coordinates from	Guide students to: • Carry out a closed compass traverse of a designated area and • Adjust using the Bowditch method.	Theodolite, Surveyors' Compass, Steel tape, EDM device, Field logbooks, Tacheometer,

traverse survey data. 4.5 Explain triangulation, its principles and applications in irrigation surveying. 4.6 State the parameters of a triangulation network: Station, - Baseline, - Azimuth determination - Selection, beaconing - Angular misclosure. 4.7 Explain the re-iteration and repetition methods of measuring triangulation angles 4.8 Describe methods of adjusting triangulation angles: triangle, braced quadrilateral and polygonal adjustments. 4.9 Define tachometry and the stadia system: fixed-hair and subtense tacheometers. 4.10 Describe the determination of tachometric constants and the subtense system. 4.11 Explain tachometric methods for plotting contours and determining spot	and coordinates from traverse survey data. - Describe triangulation, its principles and applications in irrigation surveying. - Outline the parameters of a triangulation network: Station, - Baseline, - Azimuth determination - Selection, beaconing - Angular misclosure. - Describe the re-iteration and repetition methods of measuring triangulation angles - Explain methods of adjusting triangulation angles: triangle, braced quadrilateral and polygonal adjustments. - Describe tachometry and the stadia system: fixed-hair and subtense tacheometers. - Explain the determination of tachometric constants and the subtense system. - Discuss tachometric		traverse field data - Plot the traverse. - Set up a simple triangulation network, - Measure angles - Compute unknown distances. - Conduct a tachometric exercise - Determine tachometric constants from field measurements. - Show spot heights by tachometry - Plot contours from the results.	- Calculate bearings, distances - Coordinates from traverse field data - Plot the traverse. - Set up a simple triangulation network, - Measure angles - Compute unknown distances. - Conduct a tachometric exercise - Determine tachometric constants from field measurements. - Show spot heights by tachometry - Plot contours from the results.	Ranging poles, Drawing paper, Scales, Practical manual.
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	heights.	methods for plotting contours and determining spot heights.				
GENERAL OBJECTIVE 5.0: Understand the procedures and methods of third-order theodolite and total station traversing.						
12-13	5.1 Explain the specifications for measurement of angles and distances in third-order traversing. 5.2 Describe tolerable linear and angular misclosures for secondary and tertiary traverses. 5.3 Explain the procedure for connecting to and verifying existing control points. 5.4 Explain field methods of traversing using surface taping. 5.5 Describe the precautions required in third-order field measurements. 5.6 Describe the field checks applicable to theodolite and total station traversing. 5.7 Explain the use and advantages of force-centering equipment. 5.8 Explain the role of theodolite and total	• Discuss the specifications for measurement of angles and distances in third-order traversing. • Explain tolerable linear and angular misclosures for secondary and tertiary traverses. • Describe the procedure for connecting to and verifying existing control points. • Explain field methods of traversing using surface taping. • Explain the precautions required in third-order field measurements. • Describe the field checks applicable to theodolite and total station traversing. • Explain the use and advantages of force-centering equipment.	Textbooks, E-books, Lecture notes, Whiteboard, PowerPoint Projector, Screen,	• Set up all equipment used in theodolite and total station traversing. • Carry out a theodolite traverse of the roads surrounding the school. • Compute angular and linear misclosures from the traverse data. • Plot the traverse using reduced bearings and distances. • Produce a final traverse plan using CAD software or manual drafting.	Guide students on: • Set up all equipment used in theodolite and total station traversing. • Carry out a theodolite traverse of the roads surrounding the school. • Compute angular and linear misclosures from the traverse data. • Plot the traverse using reduced bearings and distances. • Produce a final traverse plan using CAD software or manual drafting.	Theodolite, Total station, Targets, Ranging poles, Steel tape, CAD software, Drawing materials, Practical manual .

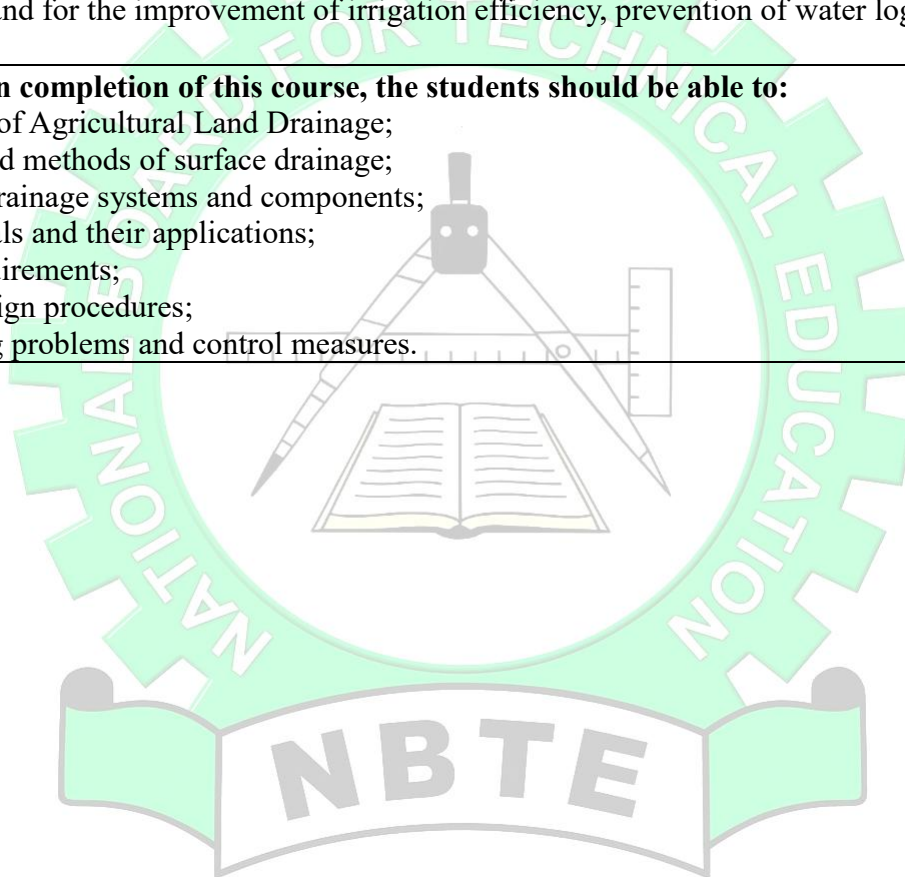
	station traversing in providing survey control. 5.9 Describe the steps for computing and adjusting bearings, distances and coordinates and producing a traverse plan.	• Discuss the role of theodolite and total station traversing in providing survey control. • Explain the steps for computing and adjusting bearings, distances and coordinates and producing a traverse plan.				
GENERAL OBJECTIVE 6.0: Understand the basic principles of using total station and GIS equipment.						
14-15	6.1 Describe a total station instrument and its accessories. 6.2 Explain the total station with a conventional theodolite. 6.3 Explain the working principles of a total station. 6.4 Discuss the procedures for observation, data recording and data retrieval with a total station. 6.5 Explain the types of GPS equipment used in irrigation surveying: handheld and tripod-mounted. 6.6 Explain the working principles of GPS and how coordinates are	• Explain a total station instrument and its accessories. • Describe the total station with a conventional theodolite. • Discuss the working principles of a total station. • Explain the procedures for observation, data recording and data retrieval with a total station. • Outline the types of GPS equipment used in irrigation surveying: handheld and tripod-mounted. • Explain the working principles of GPS and	Textbooks, E-books, Lecture notes, Whiteboard, PowerPoint Projector, Screen,	• Demonstrate the set-up and operation of a total station on a designated survey station. • Carry out a simple survey of the demonstration plot using the total station. • Retrieve field data from the total station and transfer it to a PC. • Carry out GPS observations on at least 4 selected points. • Process GPS and total station data • Produce a scaled	Guide students o: • Demonstrate the set-up and operation of a total station on a designated survey station. • Carry out a simple survey of the demonstration plot using the total station. • Retrieve field data from the total station and transfer it to a PC. • Carry out GPS observations on at least 4 selected points.	Theodolite (analog or digital), surveyors' compasses, and sextants. Steel bands, Standardize d surveyor chains, or modern Electronic Distance Measurement (EDM) devices. Field logbooks, pencils, rulers, protractors,

	determined. 6.7 Describe how GPS and GIS data are processed and used to produce survey plans and irrigation maps.	how coordinates are determined. • Discuss how GPS and GIS data are processed and used to produce survey plans and irrigation maps.		plan of the surveyed area	• Process GPS and total station data • Produce a scaled plan of the surveyed area	and Dynamic geometry software
COURSE ASSESSMENT: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						



DRAINAGE TECHNOLOGY

PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY		
COURSE TITLE: DRAINAGE TECHNOLOGY	COURSE CODE: IAT 125	CONTACT HOURS: 3 HOURS/WEEK
	CREDIT UNIT: 3	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: II	PRE-REQUISITE:	PRACTICAL: 2 HOURS/WEEK
GOAL: This course is designed to equip the student with knowledge and skill in agricultural drainage system for effective removal of excess water from agricultural land for the improvement of irrigation efficiency, prevention of water logging, and sustainable crop production.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the Concept of Agricultural Land Drainage; 2.0 Understand principles and methods of surface drainage; 3.0 Understand subsurface drainage systems and components; 4.0 Identify drainage materials and their applications; 5.0 Know drain spacing requirements; 6.0 Understand drainage design procedures; 7.0 Understand waterlogging problems and control measures.		



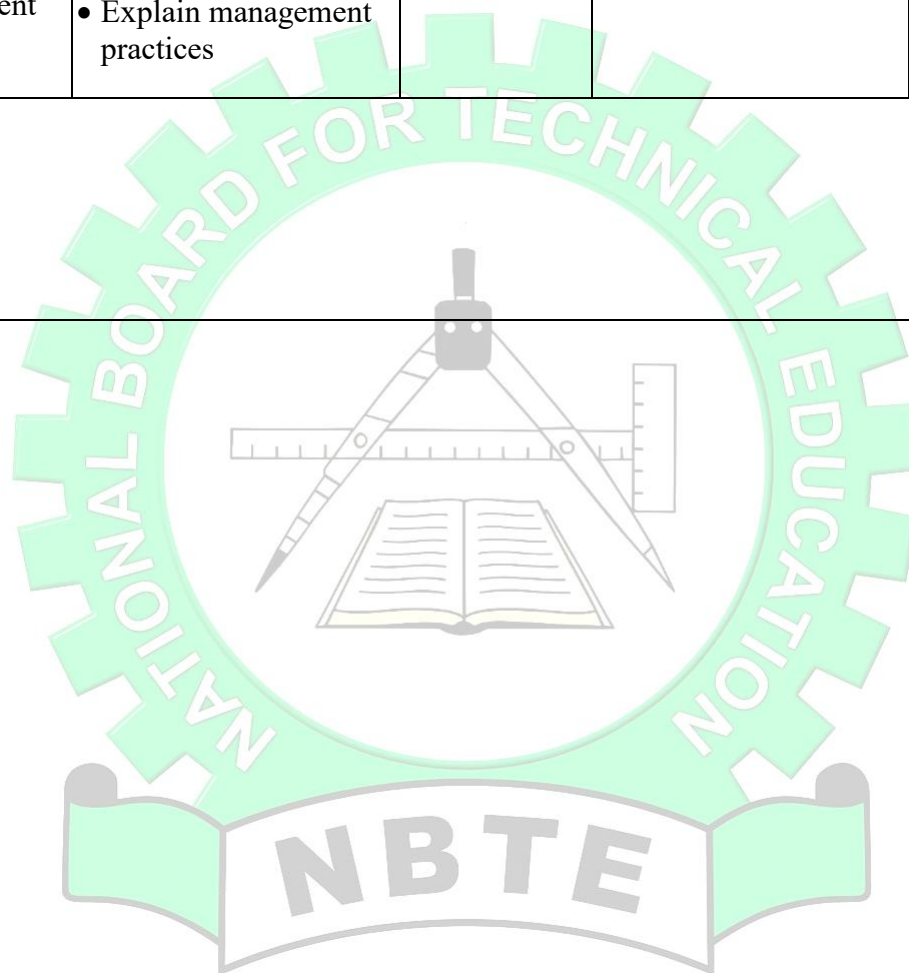
PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: DRAINAGE TECHNOLOGY			COURSE CODE: IAT 125		CONTACT HOURS: 3 HOURS/WEEK	
			CREDIT UNIT: 3		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: II			PRE-REQUISITE:		PRACTICAL: 2 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip the student with knowledge and skill in agricultural drainage system for effective removal of excess water from agricultural land for the improvement of irrigation efficiency, prevention of water logging, and sustainable crop production.						
GENERAL OBJECTIVE 1.0: Understand the concept of agricultural land drainage						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1 - 3	1.1 Define agricultural land drainage and related terminologies 1.2 Explain objectives of drainage 1.3 Describe importance of drainage in agriculture 1.4 Explain the causes of excess water accumulation 1.5 Explain the effects of poor drainage on crop production 1.6 Differentiate irrigation from drainage systems 1.7 Explain relationship between drainage and irrigation efficiency 1.8 Describe common drainage problems in irrigated agriculture	• Discuss agricultural land drainage and related terminologies • Describe objectives of drainage • Explain importance of drainage in agriculture • Discuss the causes of excess water accumulation • Discuss the effects of poor drainage on crop production • Differentiate irrigation from drainage systems • Explain relationship between drainage and irrigation efficiency • Discuss common drainage problems in irrigated agriculture	Whiteboard, charts, projector Soil samples, field photographs Diagrams,	• Visit to irrigated farms • Identify drainage features • Demonstrate drainage problems using case studies • Observe poorly drained field	Guide students to: • Visit to irrigated farms • Identify drainage features • Demonstrate drainage problems using case studies • Observe poorly drained field	Charts, Field photographs, multimedia resources Soil samples, Videos Field maps

GENERAL OBJECTIVE 2.0: Understand principles and methods of surface drainage						
4 – 6	2.1 Define surface drainage 2.2 Explain principles of surface water removal 2.3 Describe runoff movement 2.4 Highlight types of surface drainage systems 2.5 Explain functions of field drains and collector drains 2.6 Explain factors influencing surface drainage design 2.7 Explain field layout procedures 2.8 Describe maintenance practices 2.9 Explain erosion risks	• Explain surface drainage • Describe principles of surface water removal • Explain runoff movement • Outline types of surface drainage systems • Explain functions of field drains and collector drains • Discuss factors influencing surface drainage design • Explain field layout procedures • Discuss maintenance practices • Explain erosion risks	Whiteboard, charts, projector Soil samples, field photographs Diagrams,	• Identify surface drainage structures • Prepare a simple drainage layout. • Demonstrate layout methods • Demonstrate runoff pathways • Measure field slope	Guide students to: • Identify surface drainage structures • Prepare a simple drainage layout. • Demonstrate layout methods • Demonstrate runoff pathways • Measure field slope	Charts Models Drainage manuals Demonstrations farm
GENERAL OBJECTIVE 3.0: Understand subsurface drainage systems and components						
7 -9	3.1 Define subsurface drainage 3.2 Explain need for subsurface drainage 3.3 Describe groundwater movement 3.4 Explain water table concepts 3.5 Highlight components of drainage systems 3.6 Describe subsurface drainage types	• Explainsubsurface drainage • Describe need for subsurface drainage • Explain groundwater movement • Discuss water table concepts • Outline components of drainage systems • Describe subsurface drainage types	Whiteboard, charts, projector Soil samples, field photographs Diagrams,	• Demonstrate water movement in soils • Observe water table depth using observation pits. • Display drainage materials • Conduct demonstrations	Guide students to: • Demonstrate water movement in soils • Observe water table depth using observation pits. • Display drainage materials • Conduct demonstrations	Soil samples Observati on pits Pipe samples Field equipment

	3.7 Describe functions of laterals, collectors and mains 3.8 Explain installation requirements 3.9 Outline maintenance procedures	• Explain functions of laterals, collectors and mains • Discuss installation requirements • Explain maintenance procedures				
GENERAL OBJECTIVE 4.0: Identify drainage materials and their applications						
10-11	4.1 List drainage materials 4.2 Outline drainage pipes 4.3 Explain properties of drainage materials 4.4 Explain functions of filter materials 4.5 State locally available materials 4.6 Explain selection criteria 4.7 Explain storage requirements 4.8 Explain causes of material failure	• Outline drainage materials • Outline drainage pipes • Discuss properties of drainage materials • Explain functions of filter materials • Discuss locally available materials • Explain selection criteria • Explain storage requirements • Discuss causes of material failure	Whiteboard, charts, projector Soil samples, field photographs Diagrams,	• Identify drainage materials • Select suitable materials • Demonstrate proper storage methods	Guide students to: • Identify drainage materials • Select suitable materials • Demonstrate proper storage methods	Samples Catalogues Filter materials Charts PVC, Concrete and Clay pipes Field ditches
GENERAL OBJECTIVE 5.0: Know drain spacing requirements						
12	5.1 Define drain spacing 5.2 Explain the importance of spacing 5.3 State factors affecting spacing 5.4 Explain soil properties affecting spacing 5.5 Explain effects of drain depth 5.6 Explain hydraulic	• Explain drain spacing • Discuss the importance of spacing • Outline factors affecting spacing • Discuss soil properties affecting spacing • Explain effects of drain depth • Explain hydraulic	Whiteboard, charts, projector Soil samples, field photographs Diagrams,	• Demonstrate field measurement • Conduct infiltration test • Demonstrate soil evaluation • Develop spacing layout • Interpret spacing recommendations	Guide student to: • Demonstrate field measurement • Conduct infiltration test • Demonstrate soil evaluation • Develop spacing layout	Measuring tapes Soil samples Calculators

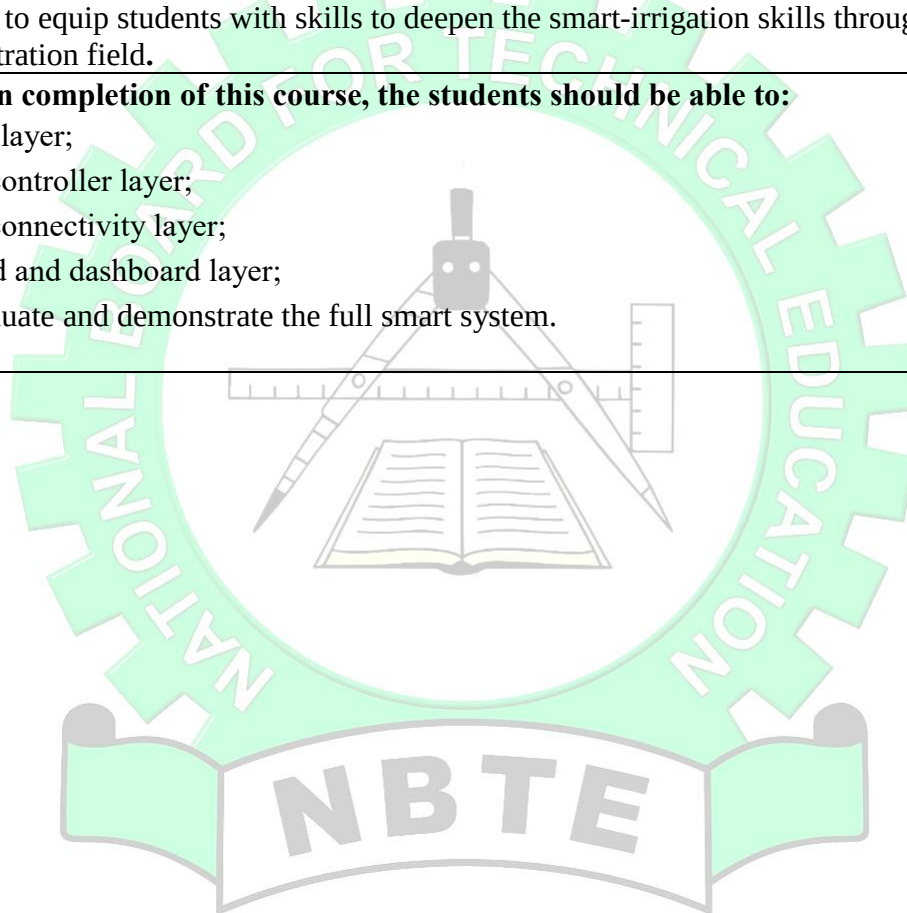
	conductivity effects 5.7 Describe spacing calculations 5.8 Explain spacing recommendations 5.9 Explain spacing principles	conductivity effects • Explain spacing calculations • Outline spacing recommendations • Discuss spacing principles			• Interpret spacing recommendations	
GENERAL OBJECTIVE 6.0: Understand drainage design procedures						
13	6.1 Define drainage design 6.2 Explain objectives of design 6.3 Explain data requirements 6.4 Explain drainage coefficients 6.5 Explain economic considerations 6.6 Explain environmental considerations	• Explain drainage design • Discuss objectives of design • Explain data requirements • Describe drainage coefficients • Explain economic considerations • Discuss environmental considerations	Whiteboard, charts, projector Soil samples, Field photographs Diagrams,	• Identify sustainable drainage design • Select suitable systems • Prepare drainage plans • Estimate materials • Conduct site investigations • Determine drain depth and layout • Prepare drainage layouts	Guide students to: • Identify sustainable drainage design • Select suitable systems • Prepare drainage plans • Estimate materials • Conduct site investigations • Determine drain depth and layout • Prepare drainage layouts	Maps Manuals Drawing tools Reports
GENERAL OBJECTIVE 7.0: Understand Waterlogging Problems and Control Measures						
14-15	7.1 Define waterlogging 7.2 Explain causes of waterlogging 7.3 Describe effects on crops and soils 7.4 Explain drainage-salinity relationship 7.5 Identify symptoms	• Explain waterlogging • Discuss causes of waterlogging • Explain effects on crops and soils • Describe drainage-salinity relationship • Outline symptoms	Whiteboard, charts, projector Soil samples, field photographs Diagrams,	• Identify waterlogging problems • Observe waterlogging indicators • Assess field problems	Guide students to: • Identify waterlogging problems • Observe waterlogging indicators • Assess field	Photos Soil samples Models

	7.6 Explain control measures 7.7 Explain agronomic control measures 7.8 Explain management practices	• Explain control measures • Explain agronomic control measures • Explain management practices		• Recommend control measures to drainage problems	problems Recommend control measures to drainage problems	
COURSE ASSESSMENT: Coursework: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

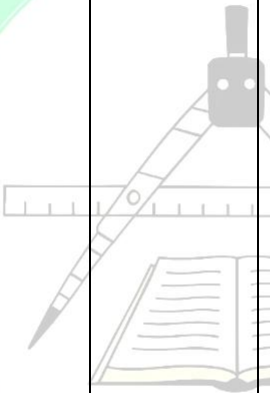
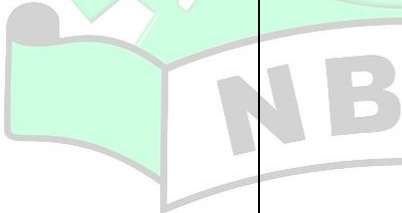


SMART IRRIGATION SYSTEMS (IOT, SENSORS AND AUTOMATION BASICS)

PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY		
COURSE TITLE: SMART IRRIGATION SYSTEMS (IoT, SENSORS AND AUTOMATION BASICS)	COURSE CODE: IAT 126	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 0
YEAR: I SEMESTER: II	PRE-REQUISITE:	PRACTICAL: 4 HOURS/WEEK
GOAL: This course is designed to equip students with skills to deepen the smart-irrigation skills through building a full IOT-enabled irrigation system on the demonstration field.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Know how to build a sensor layer; 2.0 Know how to construct the controller layer; 3.0 Know how to construct the connectivity layer; 4.0 Know how to build the cloud and dashboard layer; 5.0 Know how to construct, evaluate and demonstrate the full smart system.		



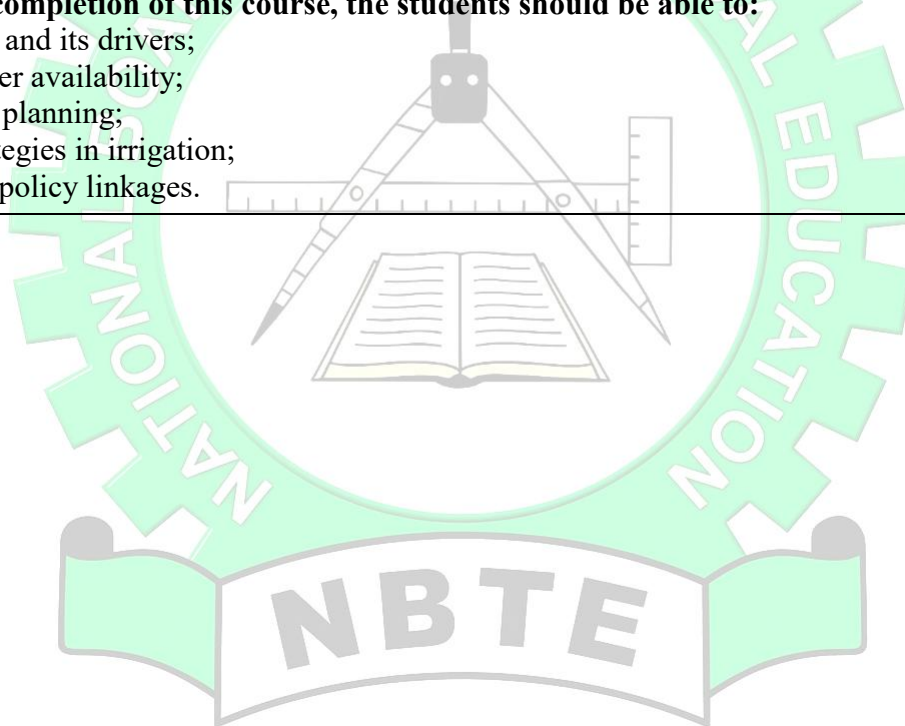
PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: SMART IRRIGATION SYSTEMS (IOT, SENSORS AND AUTOMATION BASICS)			COURSE CODE: IAT 126		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNIT: 4		THEORETICAL: 0	
YEAR: I SEMESTER: II			PRE-REQUISITE:		PRACTICAL: 4 HOURS/WEEK	
COURSE SPECIFICATION: PRACTICAL						
GOAL: This course is designed to equip students with skills to deepen the smart-irrigation skills through building a full IOT-enabled irrigation system on the demonstration field.						
GENERAL OBJECTIVE 1.0: Know how to build a sensor layer						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1–3				● Design a sensor placement map for the demo field. ● Install 4 soil-moisture sensors at 2 depths, plus temperature and rain sensors. ● Calibrate every sensor against reference methods. ● Build a sensor register with IDs, GPS coordinates ● Calibration data.	Guide students to: ●Design a sensor placement map for the demo field. ●Install 4 soil-moisture sensors at 2 depths, plus temperature and rain sensors. ●Calibrate every sensor against reference methods. ●Build a sensor register with IDs, GPS coordinates ●Calibration data.	Soil-moisture / temperature / rain sensors, GPS, Calibration kit, Demo field, Register template Etc.
GENERAL OBJECTIVE 2.0: Know how to construct the controller layer						
				● Configure an ESP32 / Raspberry Pi controller. ● Wire relays and	Guide students to: ● Configure an ESP32 / Raspberry Pi controller. ● Wire relays and	ESP32 boards, Relays, Solenoid

				solenoid valves for zone control. - Implement firmware for sensor reading and valve control. - Add safety features (timeout, fault detection).	solenoid valves for zone control. - Implement firmware for sensor reading and valve control. - Add safety features (timeout, fault detection).	valves, Jumper wires, Computer with Arduino IDE
GENERAL OBJECTIVE 3.0: Know how to construct the connectivity layer						
7–9				- Choose between Wi-Fi, GSM, LoRa for the demo site. - Configure the connectivity module. - Set up MQTT or HTTP data transmission. - Test connectivity, latency and packet loss.	Guide students to: - Choose between Wi-Fi, GSM, LoRa for the demo site. - Configure the connectivity module. - Set up MQTT or HTTP data transmission. - Test connectivity, latency and packet loss	Wi-Fi / GSM / LoRa modules, SIM cards, Network tools, Cloud broker access.
GENERAL OBJECTIVE 4.0: Know how to build the cloud and dashboard layer						
10–12				- Configure Things Board / Blynk / Node-RED for the demo system - Build a dashboard with all sensor charts and control switches - Configure alerts (SMS, email, push)	Guide students to: - Configure Things Board / Blynk / Node-RED for the demo system - Build a dashboard with all sensor charts and control switches - Configure alerts (SMS, email, push notification)	Cloud accounts, Dashboard editor, SMS/email gateway, Laptops.

				notification ● Build automation rules (e.g., irrigate when moisture < 25%)	● Build automation rules (e.g., irrigate when moisture < 25%)	
GENERAL OBJECTIVE 5.0: Know how to construct, evaluate and demonstrate the full smart system						
13–15				● Run the smart system for 4 weeks on the demo crop ● Compare water use vs a conventional control plot ● Carry out the troubleshooting ● Identify failures and remediate them ● Conduct farmer demonstration ● Document the system	Guide students to: ● Run the smart system for 4 weeks on the demo crop ● Compare water use vs a conventional control plot ● Carry out the troubleshooting ● Identify failures and remediate them ● Conduct farmer demonstration ● Document the system	Smart irrigation kits, Control plot, Water meters, Logbook.
COURSE ASSESSMENT: Course Assessment Course Assessment (Practical Based):10% Practical: 50% Examination (Practical Based): 40% Total: 100%						

CLIMATE CHANGE AND WATER RESOURCE PLANNING

PROGRAMME: NATIONAL DIPLOMA (ND) IRRIGATION AGRONOMY TECHNOLOGY		
COURSE TITLE: CLIMATE CHANGE AND WATER RESOURCE PLANNING	COURSE CODE: IAT 127	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 1 HOUR/WEEK
YEAR: I SEMESTER: II	PRE-REQUISITE: Nil	PRACTICAL: 3 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills needed to analyse how climate change affects precipitation patterns, groundwater recharge, and evapotranspiration, enabling technicians to make informed, adaptive water-management decisions.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand climate change and its drivers; 2.0 Understand impacts on water availability; 3.0 Understand water-resource planning; 4.0 Understand adaptation strategies in irrigation; 5.0 Understand mitigation and policy linkages.		



PROGRAMME: NATIONAL DIPLOMA (ND) IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: CLIMATE CHANGE AND WATER RESOURCE PLANNING			COURSE CODE: IAT 127		CONTACT HOURS: 4 HOURS/WEEK	
			CREDIT UNIT: 4		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: II			PRE-REQUISITE: Nil		PRACTICAL: 3 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills needed to analyse how climate change affects precipitation patterns, groundwater recharge, and evapotranspiration, enabling technicians to make informed, adaptive water-management decisions.						
GENERAL OBJECTIVE 1.0: Understand climate change and its drivers						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-2	1.1 Define climate, weather, climate change and variability. 1.2 Explain the drivers of climate change. (Greenhouse gases, land use, ocean cycles) 1.3 Explain climate trends in Nigeria and West Africa. 1.4 Describe the Intergovernmental Panel on Climate Change (IPCC) scenarios and their implications.	• Explain climate, weather, climate change and variability. • Explain the drivers of climate change. (Greenhouse gases, land use, ocean cycles) • Discuss climate trends in Nigeria and West Africa. • Discuss the Intergovernmental Panel on Climate Change (IPCC) scenarios and their implications.	Textbooks, Journals, Internet, Articles, Projector, Computer, Diagrams/charts, Marker board, Marker, Pictures,	• Analyse 30-year rainfall and temperature trends for a chosen station • Tabulate observed changes in onset, cessation and length of rainy season. • Compare your station data against another in a different agroecological zone. • Summarise findings in a 3-page brief.	Guide students to: • Analyse 30-year rainfall and temperature trends for a chosen station • Tabulate observed changes in onset, cessation and length of rainy season. • Compare your station data against another in a different agroecological zone. • Summarise findings in a 3-page brief.	NIMET data, IAR data Spreadsheet software, Calculators, brief templates

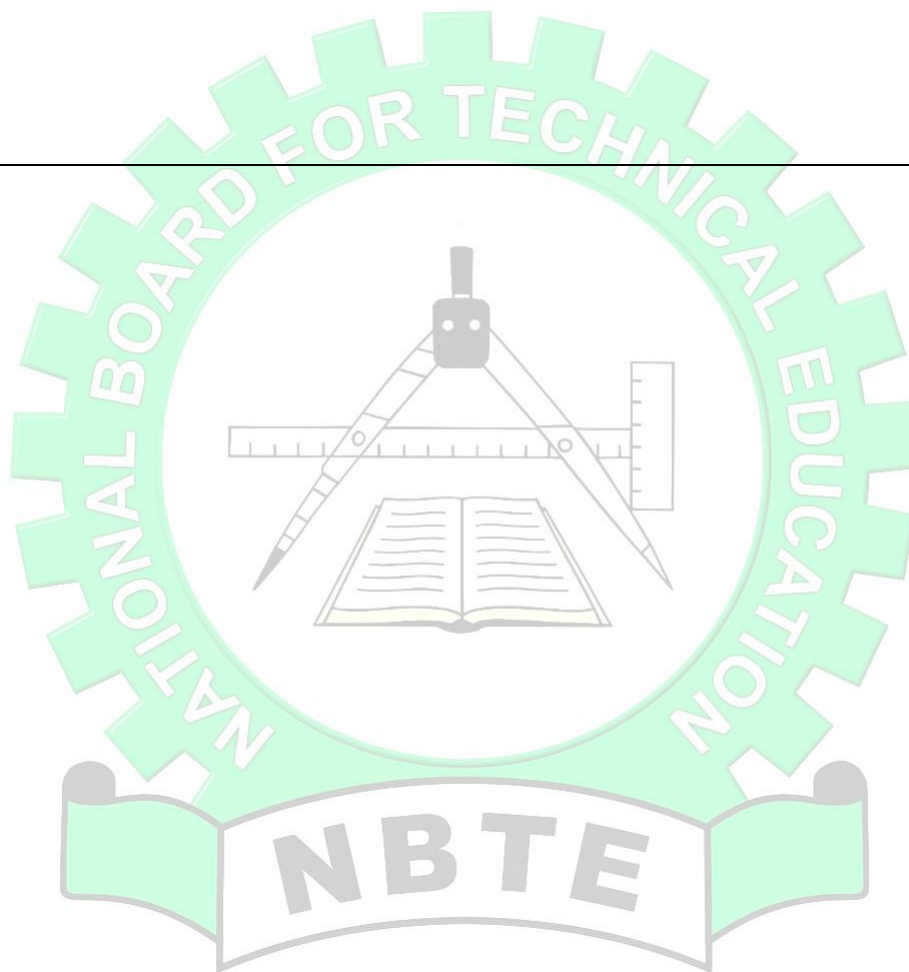
General Objective 2.0: Understand impact on water availability						
3 - 5	2.1 Explain the hydrological cycle 2.2 Describe climate-water interactions 2.3 Explain effects on water quantity and quality 2.4 Explain drought and flooding trends	- Explain the hydrological cycle - Discuss climate-water interactions - Explain effects on water quantity and quality - Discuss drought and flooding trends	Textbooks, Journals, Internet, Articles, Projector, Computer, Diagrams/charts, Marker board, Marker, Pictures,	- Draw and explain the hydrological cycle - Field observation of water bodies - Analysis of rainfall records - Flood and drought risk mapping	Guide students to: - Draw and explain the hydrological cycle - Field observation of water bodies - Analysis of rainfall records - Flood and drought risk mapping	Watershed maps Hydrological models Rainfall data GIS maps
GENERAL OBJECTIVE 3.0: Understand water-resource planning						
7-9	3.1 Describe integrated water resource management (IWRM) principles 3.2 Explain river-basin and watershed planning 3.3 Explain water-budgeting at the field and farm scale 3.4 Distinguished demand-management vs supply-augmentation strategies.	- Explain integrated water resource management (IWRM) principles - Discuss river-basin and watershed planning - Explain water-budgeting at the field and farm scale - Distinguished demand-management vs supply-augmentation strategies.	Textbooks, Journals, Internet, Articles, Projector, Computer, Diagrams/charts, Marker board, Marker, Pictures,	- Sketch the watershed for the demo plot - Build a water budget for the demo plot for one season - Identify 3 demand-side and 3 supply-side options for the watershed - Present a watershed plan for peer review.	Guide students to; - Sketch the watershed for the demo plot - Build a water budget for the demo plot for one season - Identify 3 demand-side and 3 supply-side options for the watershed - Present a watershed plan for peer review.	Watershed maps, water-budget templates, GPS, presentation slot
GENERAL OBJECTIVE 4.0: Understand adaptation strategies in irrigation						

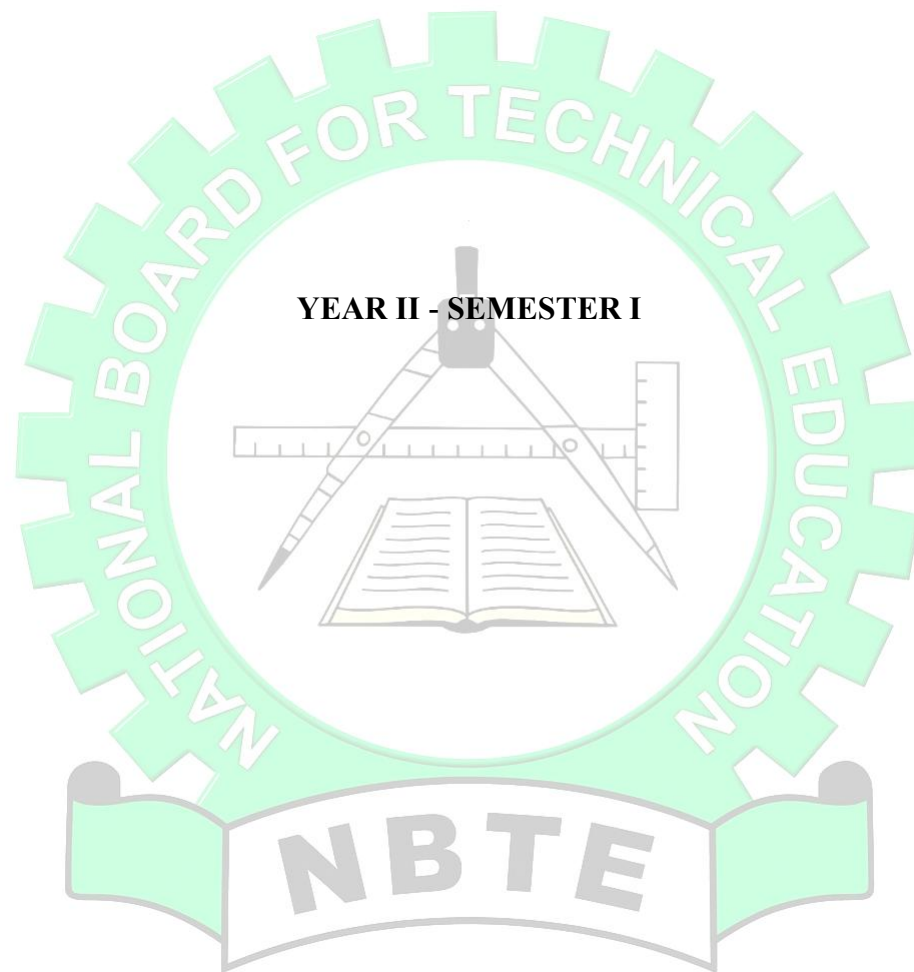
10-12	4.1 Define crop rotation and variety choice for adaptation 4.2 Explain soil-water conservation (mulching, terracing, contour bunds) 4.3 Describe rainwater harvesting and storage techniques. 4.4 Explain the efficient irrigation methods (drip, smart) for adaptation	• Explain crop rotation and variety choice for adaptation • Explain soil-water conservation (mulching, terracing, contour bunds) • Discuss rainwater harvesting and storage techniques. • Discuss the efficient irrigation methods (drip, smart) for adaptation	Textbooks, Journals, Internet, Articles, Projector, Computer, Diagrams/charts, Marker board, Marker, Pictures,	• Design a climate-adapted crop rotation for the demo farm. • Construct contour bunds and mulch on a demonstration plot. • Construct a rainwater-harvesting structure (pond or tank). • Plan a drip / smart upgrade as an adaptation measure.	Guide students to: • Design a climate-adapted crop rotation for the demo farm. • Construct contour bunds and mulch on a demonstration plot. • Construct a rainwater-harvesting structure (pond or tank). • Plan a drip / smart upgrade as an adaptation measure.	Demo plots, Tools, Mulch, Pond or tank, Drip kit, Design templates
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GENERAL OBJECTIVE 5.0: Understand mitigation and policy linkages

13-15	5.1 Explain Greenhouse Gases (GHG) emissions from irrigated systems (rice CH₄, pump CO₂). 5.2 Explain low-emission irrigation practices. 5.3 Describe Nigerian climate policies and NDC commitments. 5.4 Explain funding sources for climate-resilient irrigation	• Explain Greenhouse Gases (GHG) emissions from irrigated systems (rice CH₄, pump CO₂). • Discuss low-emission irrigation practices. • Explain Nigerian climate policies and NDC commitments. • Describe funding sources for climate-resilient irrigation	Textbooks, Journals, Internet, Articles, Projector, Computer, Diagrams/charts, Marker board, Marker, Pictures,	• Estimate emissions from a demo pump and irrigation system • Plan one low-emission upgrade (solar pump, AWD rice) • Map Nigerian climate policies relevant to irrigation • Identify 3 funding sources for climate-resilient	Guide the student to: • Estimate emissions from a demo pump and irrigation system • Plan one low-emission upgrade (solar pump, AWD rice) • Map Nigerian climate policies relevant to irrigation • Identify 3 funding sources for	Calculators, Emission factors, Upgrade design templates, Policy documents, Funding lists
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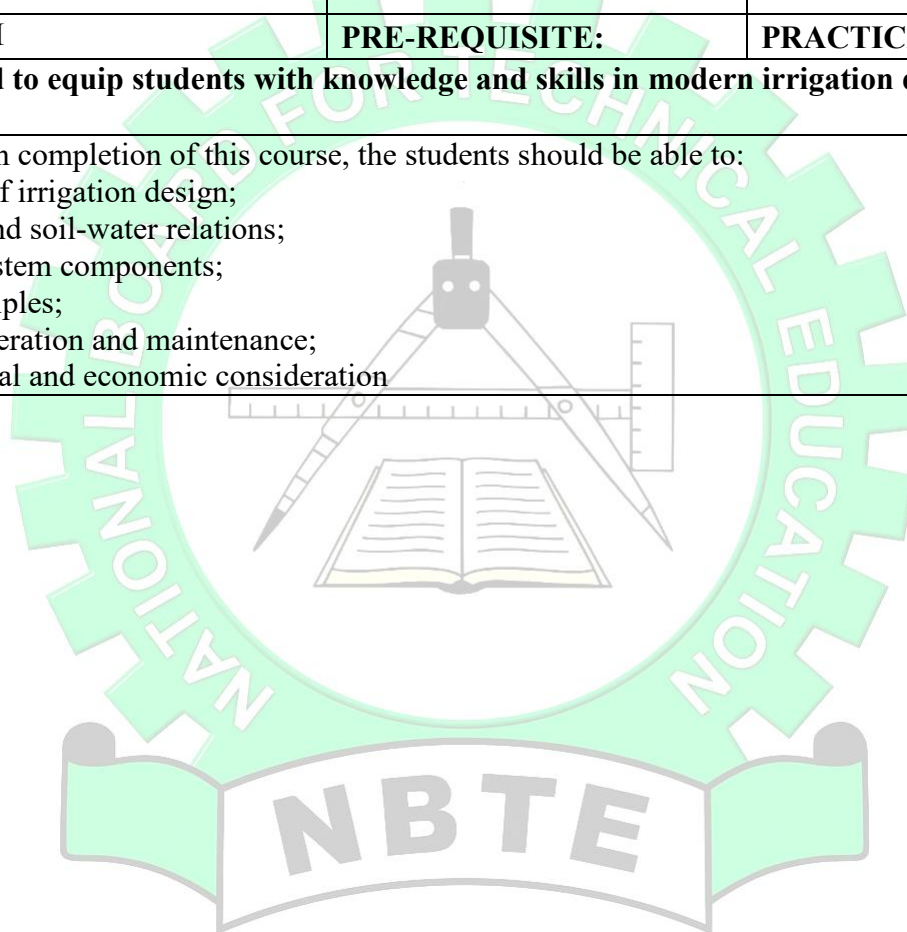
				irrigation projects	climate-resilient irrigation projects	
COURSE ASSESSMENT: Coursework: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						





INTRODUCTION TO IRRIGATION DESIGN AND SYSTEM ENGINEERING

PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY		
COURSE TITLE: INTRODUCTION TO IRRIGATION DESIGN AND SYSTEM ENGINEERING	COURSE CODE: IAT 211	CONTACT HOURS: 3 HOURS/WEEK
	CREDIT UNIT: 3	THEORETICAL: 1 HOUR/WEEK
YEAR: II SEMESTER: I	PRE-REQUISITE:	PRACTICAL: 2 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills in modern irrigation design and system engineering.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand foundation of irrigation design; 2.0 Understand hydrology and soil-water relations; 3.0 Understand irrigation system components; 4.0 Understand design principles; 5.0 Understand irrigation operation and maintenance; 6.0 Understand environmental and economic consideration		



PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: INTRODUCTION TO IRRIGATION DESIGN AND SYSTEM ENGINEERING			COURSE CODE: IAT 211		CONTACT HOURS: 3 HOURS/WEEK	
			CREDIT UNIT: 3		THEORETICAL: 1 HOUR/WEEK	
YEAR: II 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 modern irrigation design and system engineering.						
GENERAL OBJECTIVE 1.0: Understand foundation of irrigation design.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1 – 3	1.1 Explain history and important of irrigation in Agriculture 1.2 Describe the role of food security and climate 1.3 Explain irrigation methods.	• Explain history and important of irrigation in Agriculture • Explain the role of food security and climate • Describe irrigation methods.	Visual chart Diagrams, Model irrigation kits, Textbooks, Projector	• Visit a irrigation farm. • Design simple irrigation layout • Carryout infiltration tests • Carryout water source assessment	Guide students to: • Visit a irrigation farm • Design simple irrigation layout • Carryout infiltration tests • Carryout water source assessment	Auto-level, Ring, Infiltrometer s, Stopwatch, Water-yield Bucket Basic irrigation kits
GENERAL OBJECTIVE 2.0: Understand hydrology and soil-water relations						
4 – 6	2.1 Explain soil properties. 2.2 Discuss soil-water processes. 2.3 Explain how to calculate crop water requirements. 2.4 Explain analysis of water balance	• Explain soil properties. • Explain soil-water processes. • Discuss how to calculate crop water requirements. • Explain analysis of water balance • Explain soil	Visual chart Diagrams, Model irrigation kits, Textbooks, Projector	• Conduct soil infiltration test. • Determine field capacity. • Calculate rate of evapotranspiration • Design irrigation schedules. • Assess irrigation efficiency.	Guide students to: • Conduct soil infiltration test. • Determine field capacity. • Calculate rate of evapotranspiration • Design irrigation schedules.	Infiltrometer s, Moisture meter, Tensiometer, Soil sensors

	2.5 Describe soil moisture measurement. 2.6 Explain hydrological principles.	moisture measurement. • Describe hydrological principles.		• Evaluate input and output of water in soil system.	• Assess irrigation efficiency. • Evaluate input and output of water in soil system.	
GENERAL OBJECTIVE 3.0: Understand irrigation system components						
7 – 9	3.1 Explain components parts; Pumps, pipes, valves, emitters, controllers, e.t.c 3.2 Describe how each part contributes to water distribution. 3.3 Explain centrifugal / submersible / solar pumps for given duty. 3.4 Describe solar-pump sizing	- Outline components parts; Pumps, pipes, valves, emitters, controllers, e.t.c - Explain how each part contributes to water distribution. - Describe centrifugal / submersible / solar pumps for given duty. - Outline solar-pump sizing	Visual chart Diagrams, Model, Textbooks, Projector	- Carry out irrigation components selection - Assemble irrigation component parts - Carry out Irrigation components part maintenance - Carry out Solar sizing.	Guide students to: Carry out Irrigation components selection - Assemble irrigation component parts - Carry out irrigation components part maintenance - Carry out Solar sizing.	Pump catalogues, Calculators, Solar-pump Sizing tools, Vipes, Valves, Emitters.
GENERAL OBJECTIVE 4.0: Understand design principles						
10 – 12	4.1 Explain site assessment. 4.2 Explain hydraulic principles. 4.3 Describe irrigation layouts. 4.4 Explain factors that determine the	- Explain site assessment. - Discuss hydraulic principles. - Explain irrigation layouts. - Describe factors that	Design textbooks, Visual charts and diagrams, Model irrigation kit, Projector	- Design irrigation system for a smallholder farmer - Carry out flow rate, pressure, distribution efficiency - Carry out irrigation	Guide students to: - Design irrigation system for a smallholder farmer - Guide students through flow rate, pressure, distribution	Manifolds, valves, Controllers, demo field, Pressure gauges, Flowmeters, BOQ

	selection of irrigation methods.	determine the selection of irrigation methods.		plan to optimize water use and minimize losses • Design simple layout for drip let irrigation method. • Compile a Bill of Quantities and cost estimate • Present design layout to peers and revise based on feedback	efficiency • Carryout irrigation plan to optimize water use and minimize losses • Design simple layout for drip let irrigation method. • Compile a Bill of Quantities and cost estimate • Present design layout to peers and revise based on feedback	Templates
GENERAL OBJECTIVE 5.0: Understand irrigation operation and maintenance						
13 – 14	5.1 Explain irrigation system operation 5.2 Outline skills in starting, monitoring and adjusting the pump, valves, and controller 5.3 Explain water distribution 5.4 Describe irrigation routine maintenance 5.5 Explain uses of safety equipment 5.6 Describe diagnosing and fixing leakages, blockages,	• Explain irrigation system operation • Explain skills in starting, monitoring and adjusting the pump, valves, and controller • Discuss water distribution • Describe irrigation routine maintenance • Describe uses of safety equipment • Explain diagnosing and fixing leakages, blockages, pressure imbalance	Visual chart Diagrams, Model, Textbooks, Projector	• Conduct irrigation operation review • Operate irrigation equipment • Check water distribution channels • Perform routine maintenance • Apply irrigation scheduling • Document maintenance activities	Guide students to: • Conduct irrigation operation review • Operate irrigation equipment • Check water distribution channels • Perform routine maintenance • Apply irrigation scheduling • Document maintenance activities	Infiltrometer s, a stopwatch, and a water-yield bucket. Basic irrigation kits

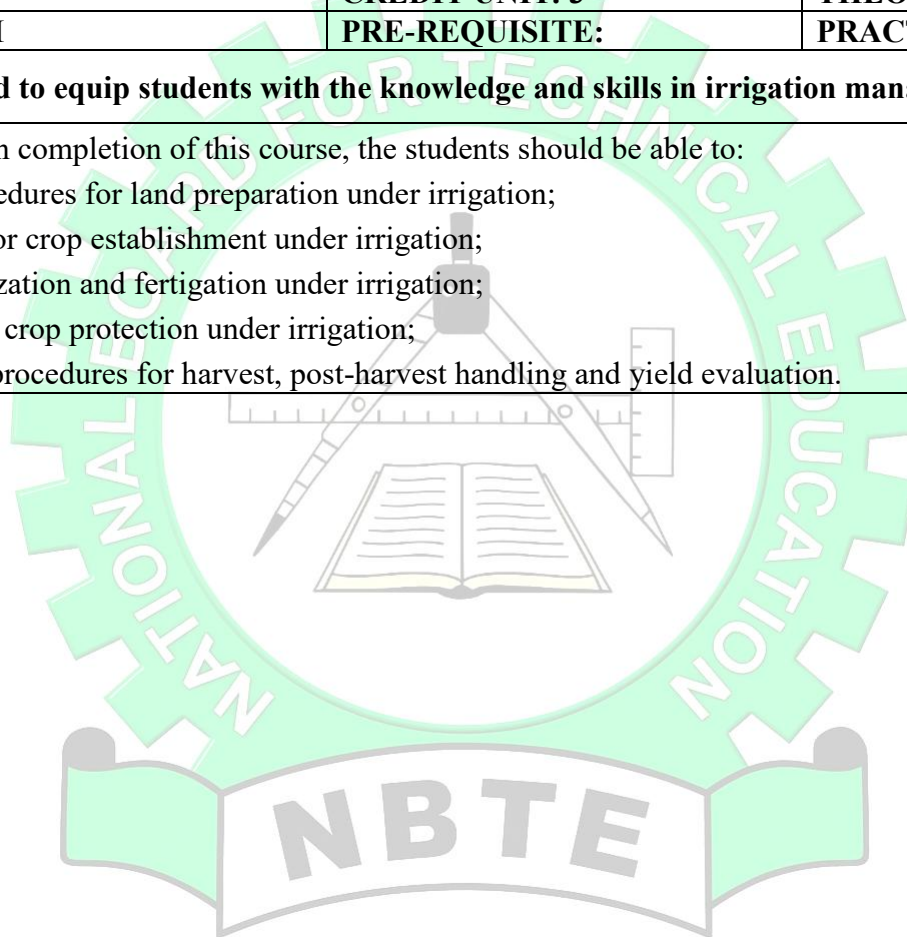
	pressure imbalance					
GENERAL OBJECTIVE 6.0: Understand environmental and economic considerations						
15	6.1 Explain environmental impact 6.2 Explain eco-friendly strategies to conserve water and protect the ecosystem 6.3 Describe energy efficiency evaluation 6.4 Explain cost-benefit analysis 6.5 Describe resource allocation 6.6 Explain economic decision-making	• Explain environmental impact • Discuss eco-friendly strategies to conserve water and protect the ecosystem • Explain energy efficiency evaluation • Describe cost-benefit analysis • Explain resource allocation • Describe economic decision-making	Visual chart Diagrams, Model, Textbooks, Projector	• Conduct environmental impact assessment • Measure water use efficiency • Analyze energy consumption • Perform cost-benefit analysis • Implement draught-resistance scheduling • Document economic and environmental data	Guide students to: • Conduct environmental impact assessment • Measure water use efficiency • Analyze energy consumption • Perform cost-benefit analysis • Implement draught-resistance scheduling • Document economic and environmental data	Financial models, cost analysis worksheet, simulation software,
COURSE ASSESSMENT: Coursework: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

IRRIGATION AGRONOMY II**PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY**

COURSE TITLE: IRRIGATION AGRONOMY II	COURSE CODE: IAT 213	CONTACT HOURS: 3 HOURS/WEEK
	CREDIT UNIT: 3	THEORETICAL: 1 HOUR/WEEK
YEAR: II SEMESTER: I	PRE-REQUISITE:	PRACTICAL: 2 HOURS/WEEK

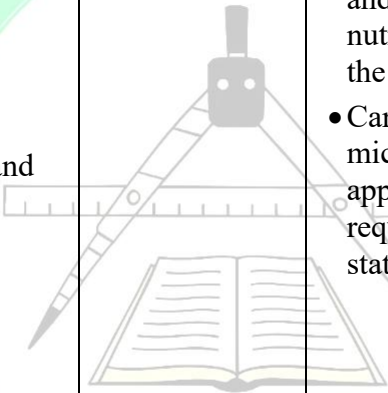
GOAL: This course is designed to equip students with the knowledge and skills in irrigation management and agronomy.**GENERAL OBJECTIVES:** On completion of this course, the students should be able to:

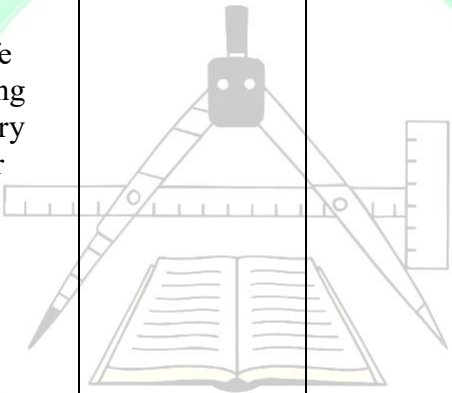
- 1.0 Know the methods and procedures for land preparation under irrigation;
- 2.0 Understand the techniques for crop establishment under irrigation;
- 3.0 Know the practices of fertilization and fertigation under irrigation;
- 6.0 Understand the principles of crop protection under irrigation;
- 5.0 Understand the criteria and procedures for harvest, post-harvest handling and yield evaluation.



PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: IRRIGATION AGRONOMY II.			COURSE CODE: IAT 213		CONTACT HOURS: 3 HOURS/WEEK	
			CREDIT UNIT: 3		THEORETICAL: 1 HOUR/WEEK	
YEAR: I SEMESTER: II			PRE-REQUISITE:		PRACTICAL: 2 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills on irrigation management and agronomy.						
GENERAL OBJECTIVE 1.0: Know the methods and procedures for land preparation under irrigation						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1– 3	1.1 Describe the procedures for primary and secondary tillage on irrigated plots. 1.2 Describe the techniques for land levelling required for surface irrigation. 1.3 Explain methods of ridge and bed formation for furrow and drip irrigation. 1.4 Explain the steps for constructing field bunds for basin irrigation.	- Describe the procedures for primary and secondary tillage on irrigated plots. - Discuss the techniques for land levelling required for surface irrigation. - Explain methods of ridge and bed formation for furrow and drip irrigation. - Explain the steps for constructing field bunds for basin irrigation.	Visual chart Diagrams, Model, Textbooks, Projector	- Carry out primary and secondary tillage on a 0.25-ha demonstration plot. - Level the plot using laser level or grade-checks. - Form ridges and beds appropriate to the planned crop. - Construct bunds around a basin irrigation plot	Guide students on; - Carry out primary and secondary tillage on a 0.25-ha demonstration plot. - Level the plot using laser level or grade-checks. - Form ridges and beds appropriate to the planned crop. - Construct bunds around a basin irrigation plot	Tractor or hand tools, Levelling equipment, Ridger, Demonstration plot.
GENERAL OBJECTIVE 2.0: Know the techniques for crop establishment under irrigation						

4- 6	2.1 Explain the procedure for seedbed preparation and how to calculate seed rates. 2.2 Describe the criteria for choosing between direct seeding and transplanting. 2.3 Outline the purpose and method of pre-emergence irrigation following planting. 2.4 Describe the recommended crop-spacing standards for irrigated production systems.	- Describe the procedure for seedbed preparation and how to calculate seed rates. - Explain the criteria for choosing between direct seeding and transplanting. - Explain the purpose and method of pre-emergence irrigation following planting. - Discuss the recommended crop-spacing standards for irrigated production systems.	Visual chart Diagrams, Model, Textbooks, Projector	- Carryout seedbed - Compute seed rate for a 0.25-ha plot of the selected crop. - Demonstrate seedlings production in the nursery - Transplant to the field. - Apply pre-emergence irrigation immediately after transplanting. - Establish correct plant spacing across the demonstration plot.	Guide students on: - Carryout seedbed - Compute seed rate for a 0.25-ha plot of the selected crop. - Demonstrate seedlings production in the nursery - Transplant to the field. - Apply pre-emergence irrigation immediately after transplanting. - Establish correct plant spacing across the demonstration plot.	Seeds/seedling, Seedling trays, Nursery materials, Demonstration plots, Hand tools.
GENERAL OBJECTIVE 3.0: Know the practices of fertilization and fertigation under irrigation						
7- 9	3.1 Describe how to interpret soil-test results and derive fertilizer recommendation	Explain how to interpret soil-test results and derive fertilizer recommendations for	Visual chart Diagrams, Model, Textbooks, Projector	Carryout base fertilizer application according to soil-test	Guide students on; Carryout base fertilizer application according to soil-	NPK fertilizers, Fertigation injector, Foliar sprayer,

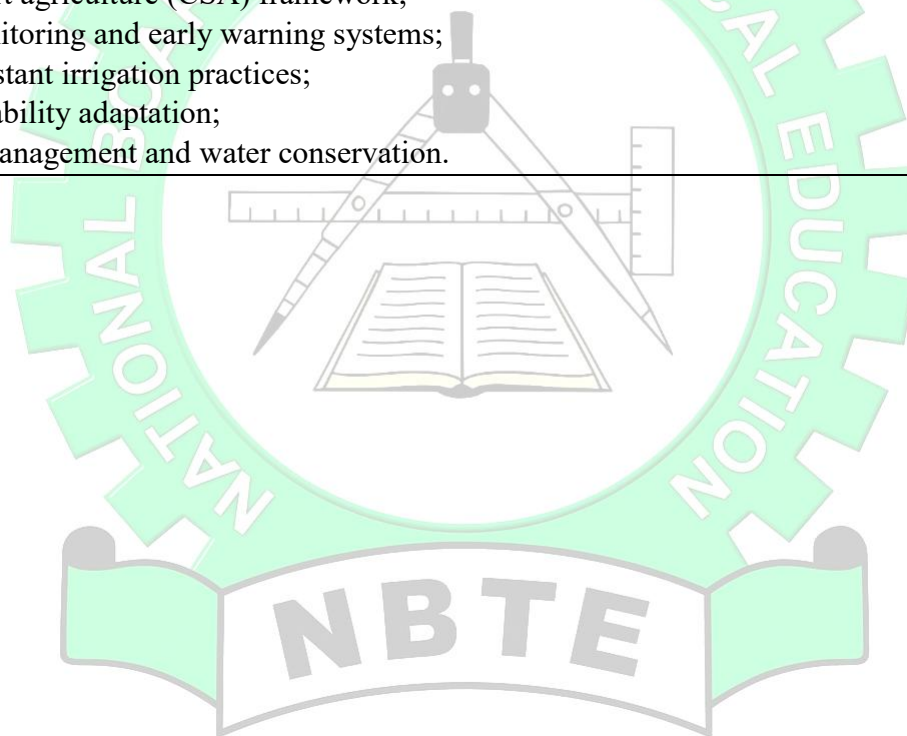
	ns for irrigated crops. 3.2 Explain the rationale and timing for split nitrogen application under irrigation. 3.3 Describe the types of fertigation equipment and the steps for their operation. 3.4 Explain the common micronutrient deficiencies in irrigated crops and how they are managed.	irrigated crops. • Describe the rationale and timing for split nitrogen application under irrigation. • Discuss the types of fertigation equipment and the steps for their operation. • Describe the common micronutrient deficiencies in irrigated crops and how they are managed.		recommendations on the demo plot • Apply split nitrogen fertilization at key growth stages through the season. • Operate a fertigation injector and deliver nutrients through the drip system. • Carryout foliar micronutrient application as required by crop status	test recommendations on the demo plot • Apply split nitrogen fertilization at key growth stages through the season. • Operate a fertigation injector and deliver nutrients through the drip system. • Carryout foliar micronutrient application as required by crop status	Demonstration plot
GENERAL OBJECTIVE 4.0: Understand the principles of crop protection under irrigation						
10 – 12	4.1 Describe the principles of integrated pest management (IPM) as applied in irrigated crop systems. 4.2 Explain the ecological basis	• Explain the principles of integrated pest management (IPM) as applied in irrigated crop systems. • Discuss the ecological basis of weed competition in irrigated plots and the	Visual chart Diagrams, Model, Textbooks, Projector	• Identify and monitor insect pests on the demonstration crop. • Carryout mechanical and chemical weed control as crop growth requires. • Manage humidity-	Guide students on; • Identify and monitor insect pests on the demonstration crop. • Carryout mechanical and chemical weed control as crop growth requires. • Manage humidity-	Monitoring traps, Herbicides, Fungicides, PPEs Knapsack sprayer Weed album Insect album.

	of weed competition in irrigated plots and the rationale for management strategies. 4.3 Describe why humidity-driven pathogens thrive under irrigation and how disease management is adapted accordingly. 4.4 Explain the principles of safe pesticide handling and the regulatory requirements for application.	rationale for management strategies. • Describe why humidity-driven pathogens thrive under irrigation and how disease management is adapted accordingly. • Discuss the principles of safe pesticide handling and the regulatory requirements for application.		driven diseases through pruning, mulching and fungicide application. • Apply pesticides safely using full personal protective equipment (PPE).	driven diseases through pruning, mulching and fungicide application. Apply pesticides safely using full personal protective equipment (PPE).	
GENERAL OBJECTIVE 5.0: Understand the criteria and procedures for harvest, post-harvest handling and yield evaluation.						
13 - 15	5.1 Describe the physiological and market-quality criteria used to determine harvest timing for major irrigated crops. 5.2 Explain the	• Explain the physiological and market-quality criteria used to determine harvest timing for major irrigated crops. • Describe the appropriate harvesting procedures and equipment for	Visual chart Diagrams, Model, Textbooks, Projector	• Determine harvest readiness using maturity indices for the demonstration crop. • Harvest the crop using appropriate hand or mechanical equipment.	Guide students on; • Determine harvest readiness using maturity indices for the demonstration crop. • Harvest the crop using appropriate hand or mechanical	Harvest tools, grading equipment, Weighing scales, Water-use records, Recording sheets Etc.

	appropriate harvesting procedures and equipment for different irrigated crops. 5.3 Describe the principles of post-harvest handling that govern quality retention. 5.4 Explain how yield and water productivity are evaluated and why systematic record keeping matters.	different irrigated crops. • Discuss the principles of post-harvest handling that govern quality retention. • Explain how yield and water productivity are evaluated and why systematic record keeping matters.		• Apply grading, washing and packaging procedures. • Measure yield, assess quality • Calculate water productivity (kg/m^3).	equipment. • Apply grading, washing and packaging procedures. • Measure yield, assess quality • Calculate water productivity (kg/m^3).	
COURSE ASSESSMENT: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

CLIMATE-SMART IRRIGATION SYSTEMS AND DROUGHT MANAGEMENT

PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY		
COURSE TITLE: CLIMATE-SMART IRRIGATION SYSTEMS AND DROUGHT MANAGEMENT	COURSE CODE: IAT 214	CONTACT HOURS: 3 HOURS/WEEK
	CREDIT UNIT: 3	THEORETICAL: 1 HOUR/WEEK
YEAR: II SEMESTER: I	PRE-REQUISITE:	PRACTICAL: 2 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills to integrate climate-smart principles into every stage of irrigation practice by ensuring reliable water delivery and crop resilience in the face of increasing drought frequency and intensity.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand climate-smart agriculture (CSA) framework; 2.0 Understand drought monitoring and early warning systems; 3.0 Understand drought-resistant irrigation practices; 4.0 Understand rainfall-variability adaptation; 5.0 Understand watershed management and water conservation.		



PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: CLIMATE-SMART IRRIGATION SYSTEMS AND DROUGHT MANAGEMENT			COURSE CODE: IAT 214		CONTACT HOURS: 3 HOURS/WEEK	
			CREDIT UNIT: 3		THEORETICAL: 1 HOUR/WEEK	
YEAR: II 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 to integrate climate-smart principles into every stage of irrigation practice by ensuring reliable water delivery and crop resilience in the face of increasing drought frequency and intensity.						
GENERAL OBJECTIVE 1.0: Understand climate-smart agriculture (CSA) framework						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1 – 3	1.1 Define Climate-smart agriculture (CSA) and its 3 pillars (productivity, adaptation, mitigation). 1.2 Explain CSA in relation to irrigation systems. 1.3 Describe climate-smart irrigation practices. 1.4 Explain CSA-readiness assessment.	• Explain Climate-smart agriculture (CSA) and its 3 pillars (productivity, adaptation, mitigation). • Discuss CSA in relation to irrigation systems. • Explain climate-smart irrigation practices. • Describe CSA-readiness assessment.	Visual chart Diagrams, Model, Textbooks, Projector	• Carryout CSA-readiness checklist on the demo farm • Evaluate 10 practices against the 3 CSA pillars. • Identify 5 priority climate-smart practices for the demo farm. • Conduct CSA plan for the demo farm.	Guide students to: • Carryout CSA-readiness checklist on the demo farm • Evaluate 10 practices against the 3 CSA pillars. • Identify 5 priority climate-smart practices for the demo farm. • Conduct CSA plan for the demo farm.	Checklists, Scoring rubrics, CSA plan templates, Field worksheets.
GENERAL OBJECTIVE 2.0: Understand drought monitoring and early warning systems						
4 - 6	2.1 Explain meteorological, agricultural and hydrological droughts.	• Discuss meteorological, agricultural and hydrological droughts.	Visual chart Diagrams, Model, Textbooks, Projector	• Compute SPI for a chosen station using the 5 most recent years.	Guide students to: • Compute SPI for a chosen station using the 5 most recent years.	Climate data, Manuals, FAO CLIMWAT,

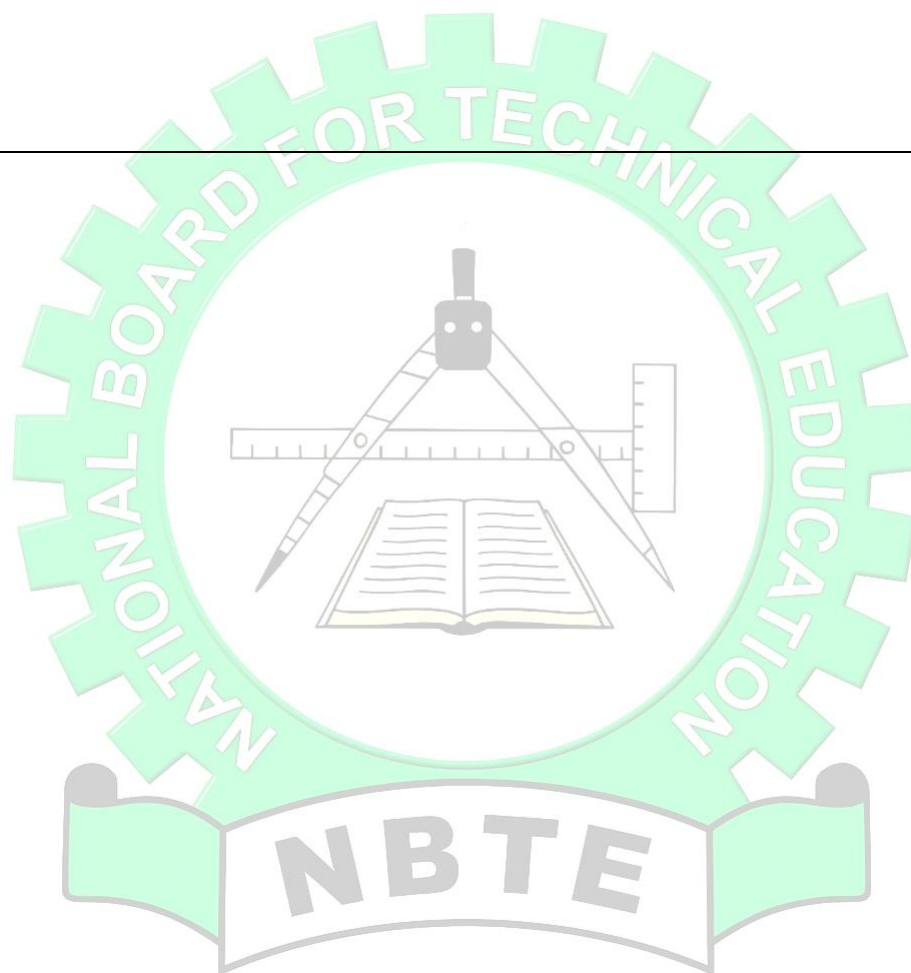
	2.2 Explain drought indices (Standardized Precipitation index (SPI), Standardized Precipitation Evapotranspiration Index (SPEI), Vegetation Health Index (VHI) basics) 2.3 List early-warning sources (NIMET, FEWS NET, GLDAS). 2.4 Describe drought-forecasting applications.	• Discuss drought indices (Standardized Precipitation index (SPI), Standardized Precipitation Evapotranspiration Index (SPEI), Vegetation Health Index (VHI) basics) • Outline early-warning sources (NIMET, FEWS NET, GLDAS). • Explain drought-forecasting applications.		• Browse FEWS NET / NIMET drought maps. • Subscribe to one drought-EW service (FEWS NET, NIMET etc) • Interpret a sample drought forecast.	• Browse FEWS NET / NIMET drought maps. • Subscribe to one drought-EW service (FEWS NET, NIMET etc) • Interpret a sample drought forecast.	IRI, Calculators, Internet, Sample forecasts E-library.
GENERAL OBJECTIVE 3.0: Understand drought-resistant irrigation practices						
7 – 9	3.1 Describe deficit irrigation for drought management. 3.2 Explain water harvesting and storage (in-field and on-farm). 3.3 Explain mulching and shade for evaporation reduction. 3.4 Describe drought-tolerant cultivars.	• Explain deficit irrigation for drought management. • Describe water harvesting and storage (in-field and on-farm). • Discuss mulching and shade for evaporation reduction. • Explain drought-tolerant cultivars.	Visual chart Diagrams, Model, Textbooks, Projector	• Demonstrate a deficit-irrigation plot alongside a normal plot. • Construct or maintain an on-farm water-storage pond / tank. • Demonstrate organic and plastic mulch on demo plots. • Plant drought-tolerant cultivars and compare with non-tolerant.	Guide students to: • Demonstrate a deficit-irrigation plot alongside a normal plot. • Construct or maintain an on-farm water-storage pond / tank. • Demonstrate organic and plastic mulch on demo plots. Plant drought-tolerant cultivars and compare with non-tolerant.	Demo plots, Pond/tank, Mulch materials, Cultivar seeds.

GENERAL OBJECTIVE 4.0: Understand rainfall-variability adaptation.						
10 – 12	4.1 Discuss required adjustments for the delayed onset of rains. 4.2 Describe adjustments for early cessation. 4.3 Explain dry-spell management within a season. 4.4 Explain supplementary irrigation strategies	• Discuss required adjustments for the delayed onset of rains. • Describe adjustments for early cessation. • Explain dry-spell management within a season. • Explain supplementary irrigation strategies	Visual chart Diagrams, Model, Textbooks, Projector	• Use planting date based on observed rainfall onset. • Demonstrate <u>on</u> the use of early-maturing varieties for early cessation. • Demonstrate how to manage 2 dry-spell events with timely irrigation. • Plan for supplementary irrigation for a rain-fed plot.	Guide students to: • Use planting date based on observed rainfall onset. • Demonstrate <u>on</u> the use of early-maturing varieties for early cessation. • Demonstrate how to manage 2 dry-spell events with timely irrigation. • Plan for supplementary irrigation for a rain-fed plot.	Rainfall records, Calendar templates, NIMET data E-library Demo plots
GENERAL OBJECTIVE 5.0: Understand watershed management and water conservation						
13 – 15	5.1 Explain watershed delineation and characterisation. 5.2 Describe soil and water conservation structures. 5.3 Explain groundwater (GW) conservation practices. 5.4 Explain community-based water management.	• Describe watershed delineation and characterization. • Explain conservation structures. • Discuss GW practices. • Describe community-based water management.	Visual chart Diagrams, Model, Textbooks, Projector	• Delineate the watershed of the demo farm using GPS and a map. • Construct contour bunds and gully-control structures. • Describe recharge pits or check dams (or inspect existing one). • Engage community group in water-management planning.	Guide students to: • Delineate the watershed of the demo farm using GPS and a map. • Construct contour bunds and gully-control structures. • Describe recharge pits or check dams (or inspect existing one). • Engage community group in water-management	Maps, GPS, Construction tools, Community contacts, Watershed manuals.

planning.

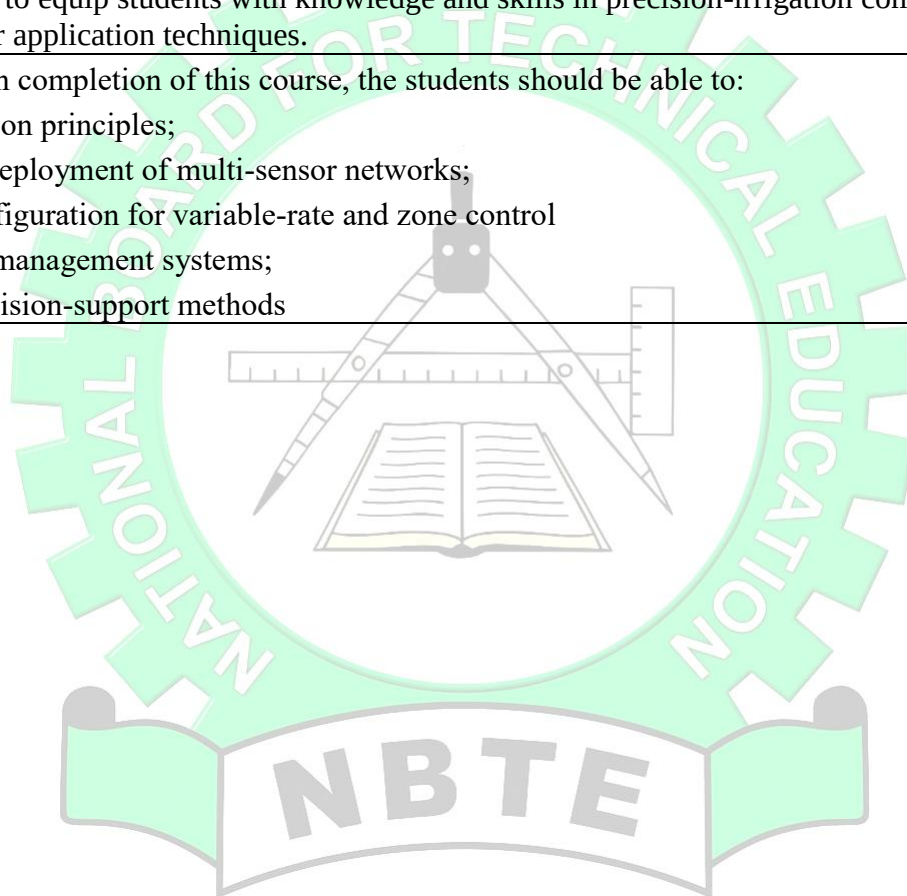
COURSE ASSESSMENT:

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



PRECISION IRRIGATION AND SENSOR-BASED WATER MANAGEMENT

PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY		
COURSE TITLE: PRECISION IRRIGATION AND SENSOR BASED WATER MANAGEMENT	COURSE CODE: IAT 212	CONTACT HOURS: 3 HOURS/WEEK
	CREDIT UNIT: 3	THEORETICAL: 1 HOUR/WEEK
YEAR: II SEMESTER: I	PRE-REQUISITE:	PRACTICAL: 2 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills in precision-irrigation competencies using multi-sensor networks and variable-rate water application techniques.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand precision irrigation principles; 2.0 Know the components and deployment of multi-sensor networks; 3.0 Know the hardware and configuration for variable-rate and zone control 4.0 Understand real-time water management systems; 5.0 Know data analytics and decision-support methods		



PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: PRECISION IRRIGATION AND SENSOR BASED WATER MANAGEMENT			COURSE CODE: IAT 212		CONTACT HOURS: 3 HOURS/WEEK	
			CREDIT UNIT: 3		THEORETICAL: 1 HOUR/WEEK	
YEAR: II SEMESTER: I			PRE-REQUISITE:		PRACTICAL: 2 HOURS/WEEK	
GOAL: This course is designed to equip students with knowledge and skills in precision-irrigation competencies using multi-sensor networks and variable-rate water application techniques.						
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GENERAL OBJECTIVE 1.0: Understand precision irrigation principles.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1-3	1.1 Describe the concept of precision irrigation and variable-rate irrigation (VRI). 1.2 Explain field-zoning principles based on soil and crop variability. 1.3 Describe how prescription maps are developed and used for VRI. 1.4 Explain the differences in outcomes between uniform and precision irrigation.	• Explain the concept of precision irrigation and variable-rate irrigation (VRI). • Describe field-zoning principles based on soil and crop variability. • Explain how prescription maps are developed and used for VRI. • Discuss the differences in outcomes between uniform and precision irrigation.	Visual chart Diagrams, Model, Textbooks, Projector	• Map soil variability across the demo plot using EC or texture measurement • Identify 3–4 management zones from the variability map. • Create a prescription map for irrigation depth by zone • Run zoned irrigation • Compare results with a uniform-application plot	Guide students to: • Map soil variability across the demo plot using EC or texture measurement • Identify 3–4 management zones from the variability map. • Create a prescription map for irrigation depth by zone • Run zoned irrigation • Compare results with a uniform-application plot	EC meter, Soil-texture kit, GPS, GIS / paper maps, Demo field.

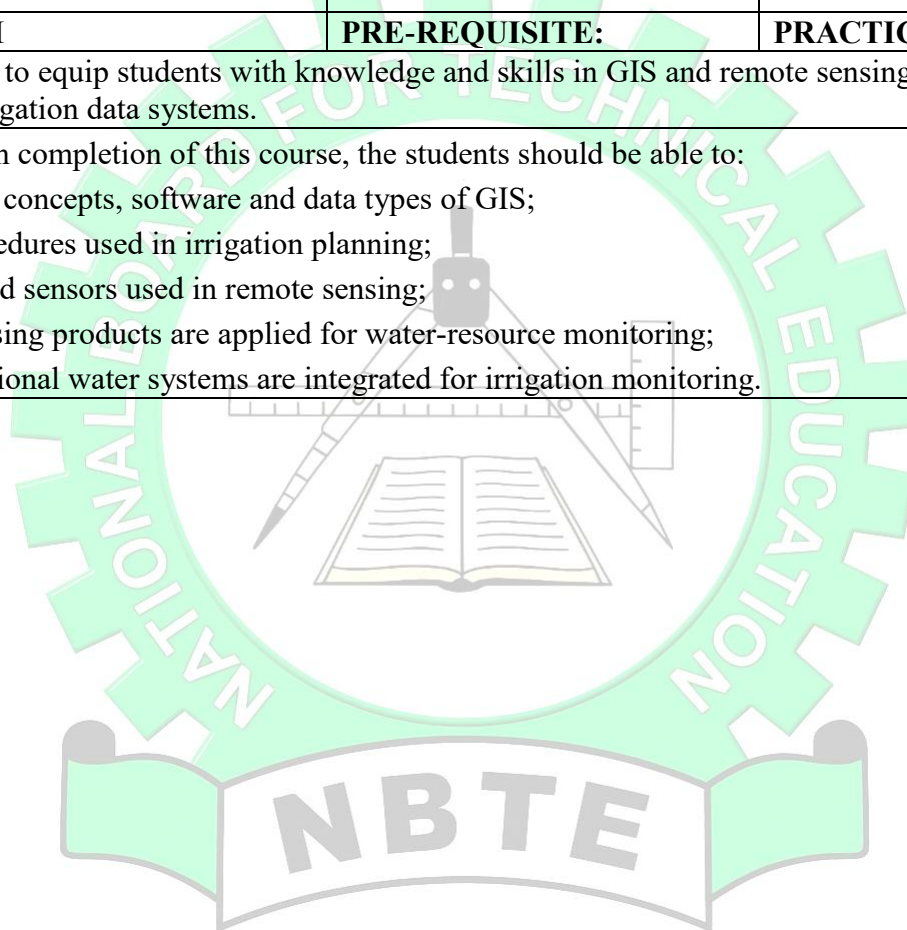
GENERAL OBJECTIVE 2.0: Know the components and deployment of multi-sensor networks.						
4-6	2.1 Explain the types of sensors used in multi-sensor irrigation networks: - Soil-moisture - Weather sensor - Crop-canopy sensors. 2.2 Discuss the basic principles of data fusion in multi-sensor systems. 2.3 Describe the methods of spatial interpolation between sensor points. 2.4 Explain how alert thresholds are set for multi-sensor irrigation decisions	- Explain the types of sensors used in multi-sensor irrigation networks: - Soil-moisture - Weather sensor - Crop-canopy sensors. - Describe the basic principles of data fusion in multi-sensor systems. - Discuss the methods of spatial interpolation between sensor points. - Explain how alert thresholds are set for multi-sensor irrigation decisions	Visual chart Diagrams, Model, Textbooks, Projector	- Deploy 4 soil-moisture sensors + 1 weather station + 1 canopy sensor on the demo field. - Stream all data to a single monitoring dashboard. - Interpolate a soil-moisture map across the field. - Configure compound alerts using multiple sensor inputs.	Guide students to: - Deploy 4 soil-moisture sensors + 1 weather station + 1 canopy sensor on the demo field. - Stream all data to a single monitoring dashboard. - Interpolate a soil-moisture map across the field. - Configure compound alerts using multiple sensor inputs.	Soil-moisture / weather / canopy sensors, dashboard platform, GIS / mapping tool
GENERAL OBJECTIVE 3.0: Know the hardware and configuration for variable-rate and zone control.						
7-9	3.1 Describe the VRI hardware components: - Solenoid valves, - Variable-speed drives, - Individual zone valves. 3.2 Explain how controllers are	- Explain the VRI hardware components: - Solenoid valves, - Variable-speed drives, - Individual zone valves. - Describe how controllers are	VRI equipment catalogues, Controller manuals, Projector	- Install zone valves for 3 management zones on the demo field. - Program the controller to apply different irrigation depths per zone. - Run a fertigation cycle with different application rates per	Guide students on: - Install zone valves for 3 management zones on the demo field. - Program the controller to apply different irrigation depths	Solenoid valves, Zone controllers, Fertigation injector, Demo zones.

	configured for differential irrigation depth by zone. 3.3 Describe how spatial differentiation is applied in variable-rate fertigation. 3.4 Explain the methods used to evaluate water-use and yield benefits of VRI.	configured for differential irrigation depth by zone. • Explain how spatial differentiation is applied in variable-rate fertigation. • Describe the methods used to evaluate water-use and yield benefits of VRI.		zone. • Tabulate water applied and yield per zone and compute the benefit.	per zone. • Run a fertigation cycle with different application rates per zone. • Tabulate water applied and yield per zone and compute the benefit.	
GENERAL OBJECTIVE 4.0: Understand real-time water management systems.						
9- 12	4.1 Describe how real-time monitoring dashboards are structured and configured. 4.2 Explain how automation rules and AI-assisted scheduling interact in irrigation systems. 4.3 Explain how remote system operation works via web and mobile applications. 4.4 Describe cybersecurity principles relevant to IoT-based irrigation systems.	• Explain how real-time monitoring dashboards are structured and configured. • Describe how automation rules and AI-assisted scheduling interact in irrigation systems. • Describe how remote system operation works via web and mobile applications. • Explain cybersecurity principles relevant to IoT-based irrigation systems.	Platform manuals, Security guidelines, Projector	• Build a real-time dashboard for the multi-sensor network • Configure 5 automation rules (irrigate, alert, throttle) • Operate the irrigation system remotely via a mobile app. • Apply basic security measures: TLS, strong credentials firmware updates.	Guide students to: • Build a real-time dashboard for the multi-sensor network • Configure 5 automation rules (irrigate, alert, throttle) • Operate the irrigation system remotely via a mobile app. • Apply basic security measures: TLS, strong credentials firmware updates.	Cloud platform accounts, Smartphones, Security checklist Etc.
GENERAL OBJECTIVE 5.0: Understand data analytics and decision-support methods						

13-15	5.1 Describe how descriptive analytics are applied to daily irrigation sensor data. 5.2 Explain the principles of trend analysis and anomaly detection in sensor data. 5.3 Explain how the correlation between sensor data and crop response informs decisions. 5.4 Describe how analytical results are presented as improvement recommendations.	• Explain how descriptive analytics are applied to daily irrigation sensor data. • Describe the principles of trend analysis and anomaly detection in sensor data. • Discuss how the correlation between sensor data and crop response informs decisions. • Explain how analytical results are presented as improvement recommendations.	Visual chart Diagrams, Model, Textbooks, Projector	• Compute summary statistics on 4 weeks of sensor data. • Detect trends and anomalies in the dataset. • Correlate soil-moisture and ET trends with crop yield by zone. • Present a 6-page water-management analytics report.	Guide students to: • Compute summary statistics on 4 weeks of sensor data. • Detect trends and anomalies in the dataset. • Correlate soil-moisture and ET trends with crop yield by zone. • Present a 6-page water-management analytics report.	Computers , Spreadsheet or Python tools, Sample datasets, Report templates Etc.
COURSE ASSESSMENT: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

INTRODUCTION TO GIS AND REMOTE SENSING FOR WATER MONITORING SYSTEMS

PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY		
COURSE TITLE: INTRODUCTION TO GIS AND REMOTE SENSING FOR WATER MONITORING SYSTEMS	COURSE CODE: IAT 215	CONTACT HOURS: 3 HOURS/WEEK
	CREDIT UNIT: 3	THEORETICAL: 1 HOUR/WEEK
YEAR: II SEMESTER: I	PRE-REQUISITE:	PRACTICAL: 2 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills in GIS and remote sensing for irrigation water-monitoring decisions, including national irrigation data systems.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the fundamental concepts, software and data types of GIS; 2.0 Know the GIS analysis procedures used in irrigation planning; 3.0 Understand the principles and sensors used in remote sensing; 4.0 Understand how remote sensing products are applied for water-resource monitoring; 5.0 Know how GIS, IoT and national water systems are integrated for irrigation monitoring.		



PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: INTRODUCTION TO GIS AND REMOTE SENSING FOR WATER MONITORING SYSTEMS			COURSE CODE: IAT 215		CONTACT HOURS: 3 HOURS/WEEK	
			CREDIT UNIT: 3		THEORETICAL: 1 HOUR/WEEK	
Year: II 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 GIS and remote sensing for irrigation water-monitoring decisions, including national irrigation data systems.						
GENERAL OBJECTIVE 1.0: Understand the fundamental concepts, software and data types of GIS						
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, map layers, vector data and raster data. 1.2 Explai the main GIS software options: QGIS (free) and ArcGIS (commercial) 1.3 Explain the common coordinate reference systems and projections used in irrigation GIS. 1.4 Describe the key data sources used in irrigation GIS: administrative boundaries, soils, rivers and roads	• Explain GIS, map layers, vector data and raster data. • Discuss the main GIS software options: QGIS (free) and ArcGIS (commercial) • Explain the common coordinate reference systems and projections used in irrigation GIS. • Describe the key data sources used in irrigation GIS: administrative boundaries, soils, rivers and roads	Visual chart Diagrams, Model, Textbooks, Projector	• Demonstrate the installation of QGIS on lab computers. • Show loading of 4 layers (boundaries, soil, rivers, roads) for one local area. • Project all layers to the correct coordinate reference system. • Produce a basic printed map displaying all 4 layers	Guide students to; • Demonstrate the installation of QGIS on lab computers. • Show loading of 4 layers (boundaries, soil, rivers, roads) for one local area. • Project all layers to the correct coordinate reference system. • Produce a basic printed map displaying all 4 layers	Computers with QGIS, Sample spatial data, Internet access.
GENERAL OBJECTIVE 2.0: Know the GIS analysis procedures used in irrigation planning						

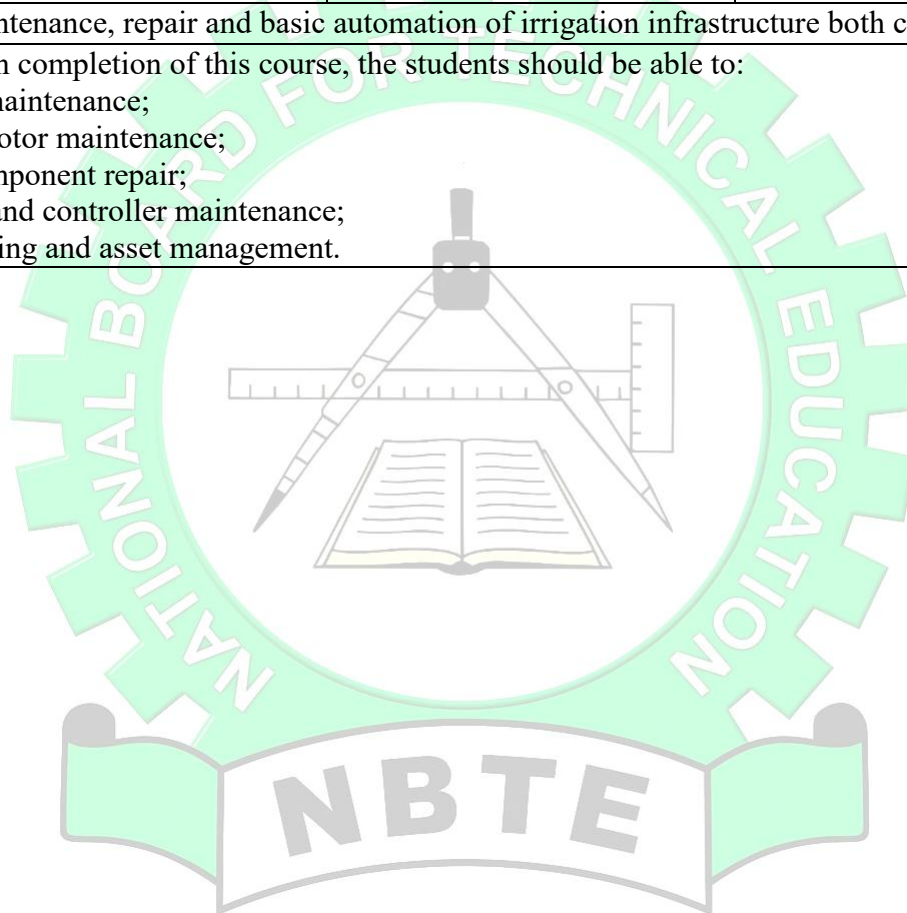
4 - 6	2.1 Outline the steps for conducting land-suitability analysis for irrigation based on soils, slope and water proximity 2.2 Explain the procedure for overlay analysis to combine multiple suitability criteria 2.3 Describe buffer and proximity analysis is performed for irrigation planning 2.4 State the tools and steps for terrain analysis: slope, aspect and watershed delineation	• Outline the steps for conducting land-suitability analysis for irrigation based on soils, slope and water proximity • Describe the procedure for overlay analysis to combine multiple suitability criteria • Explain buffer and proximity analysis is performed for irrigation planning • Outline the tools and steps for terrain analysis: slope, aspect and watershed delineation	Visual chart Diagrams, Model, Textbooks, Projector	• Run a 3-layer suitability analysis for irrigation around the demo farm • Apply overlay to combine soil-suitability with water-availability layers • Buffer rivers and exclude flood-prone zones from the suitability map • Run slope analysis and watershed delineation for the demo farm	Guide students to: • Run a 3-layer suitability analysis for irrigation around the demo farm • Apply overlay to combine soil-suitability with water-availability layers • Buffer rivers and exclude flood-prone zones from the suitability map • Run slope analysis and watershed delineation for the demo farm	QGIS, digital elevation model (DEM) data, and irrigation case-study datasets
GENERAL OBJECTIVE 3.0: Understand the principles and sensors used in remote sensing						
7 – 9	3.1 Define the electromagnetic principles that underpin how remote sensing works. 3.2 Explain the characteristics and appropriate uses of common satellite sensors: Landsat, Sentinel-2 and MODIS.	• Explain the electromagnetic principles that underpin how remote sensing works. • Describe the characteristics and appropriate uses of common satellite sensors: Landsat, Sentinel-2 and MODIS.	Visual chart Diagrams, Model, Textbooks, Projector	• Download a Sentinel-2 image of the farm area from Copernicus Open Access Hub. • Compute NDVI and NDWI for the study area in QGIS. • Compare NDVI of an irrigated plot vs a rain-fed	Guide students to; • Download a Sentinel-2 image of the farm area from Copernicus Open Access Hub. • Compute NDVI and NDWI for the study area in QGIS. • Compare NDVI	QGIS, Sentinel-2 imagery, internet access.

	3.3 Explain how spectral indices (NDVI, NDWI, evaporative fraction) are derived and what they indicate 3.4 Explain how temporal analysis of multi-date imagery reveals crop growth and water-body change	- Describe how spectral indices (NDVI, NDWI, evaporative fraction) are derived and what they indicate - Discuss how temporal analysis of multi-date imagery reveals crop growth and water-body change		plot. Build a 4-date temporal NDVI series for the demo crop season	of an irrigated plot vs a rain-fed plot. Build a 4-date temporal NDVI series for the demo crop season	
GENERAL OBJECTIVE 4.0: Understand how remote sensing products are applied for water-resource monitoring.						
10 – 12	4.1 Explain how SEBAL and METRIC algorithms estimate evapotranspiration from remote sensing data. 4.2 Explain how satellite soil-moisture products (SMAP, SMOS) are generated and interpreted. 4.3 Explain how multi-date satellite imagery is used to monitor reservoir and river extent changes 4.4 Outline how satellite-derived drought indices are interpreted and applied in irrigation management	- Discuss how SEBAL and METRIC algorithms estimate evapotranspiration from remote sensing data. - Discuss how satellite soil-moisture products (SMAP, SMOS) are generated and interpreted. - Discuss how multi-date satellite imagery is used to monitor reservoir and river extent changes - Explain how satellite-derived drought indices are interpreted and applied in irrigation management	Visual chart Diagrams, Model, Textbooks, Projector	- Interpret a published remote-sensing ET map for Nigeria. - Examine SMAP soil-moisture data for the demo region. - Monitor a local reservoir surface area over 12 months using Sentinel-2 imagery. - Build a drought index time series from MODIS data	Guide students to: - Interpret a published remote-sensing ET map for Nigeria. - Examine SMAP soil-moisture data for the demo region. - Monitor a local reservoir surface area over 12 months using Sentinel-2 imagery. - Build a drought index time series from MODIS data	QGIS, SMAP data, MODIS data, and internet access
GENERAL OBJECTIVE 5.0: Understand how GIS, IOT and national water systems are integrated for irrigation monitoring.						

13 – 15	5.1 Explain how IoT sensor data is georeferenced and integrated into a GIS for irrigation monitoring. 5.2 Outline how satellite-derived layers are combined with field GIS data to produce monitoring outputs. 5.3 Describe the role of national irrigation data systems — NIWRMC and NIHSA — in water-resource management. 5.4 Explain the principles of open data and why data sharing matters in national water management	• Discuss how IoT sensor data is georeferenced and integrated into a GIS for irrigation monitoring. • Outline how satellite-derived layers are combined with field GIS data to produce monitoring outputs. • Explain the role of national irrigation data systems — NIWRMC and NIHSA — in water-resource management. • Describe the principles of open data and why data sharing matters in national water management	Visual chart Diagrams, Model, Textbooks, Projector	• Plot IoT sensor points on the GIS map with full attribute data. • Overlay sensor data with NDVI and remote-sensing ET layers in QGIS. • Browse the NIWRMC website and retrieve irrigation data for one irrigation scheme. • Prepare a 5-page integrated monitoring report combining field IoT and satellite data	Guide students to: • Plot IoT sensor points on the GIS map with full attribute data. • Overlay sensor data with NDVI and remote-sensing ET layers in QGIS. • Browse the NIWRMC website and retrieve irrigation data for one irrigation scheme. Prepare a 5-page integrated monitoring report combining field IoT and satellite data	QGIS, IoT sensor dataset, satellite data layers, internet access
COURSE ASSESSMENT: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

IRRIGATION MAINTENANCE, REPAIR AND AUTOMATION SYSTEMS

PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY		
COURSE TITLE: IRRIGATION MAINTENANCE, REPAIR AND AUTOMATION SYSTEMS	COURSE CODE: IAT 216	CONTACT HOURS: 3 HOURS/WEEK
	CREDIT UNIT: 3	THEORETICAL: 1 HOUR/WEEK
YEAR: II SEMESTER: I	PRE-REQUISITE:	PRACTICAL: 2 HOURS/WEEK
GOAL: This course covers maintenance, repair and basic automation of irrigation infrastructure both classical and smart systems.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand preventive maintenance; 2.0 Understand pump and motor maintenance; 3.0 Understand pipe and component repair; 4.0 Understand automation and controller maintenance; 5.0 Understand troubleshooting and asset management.		



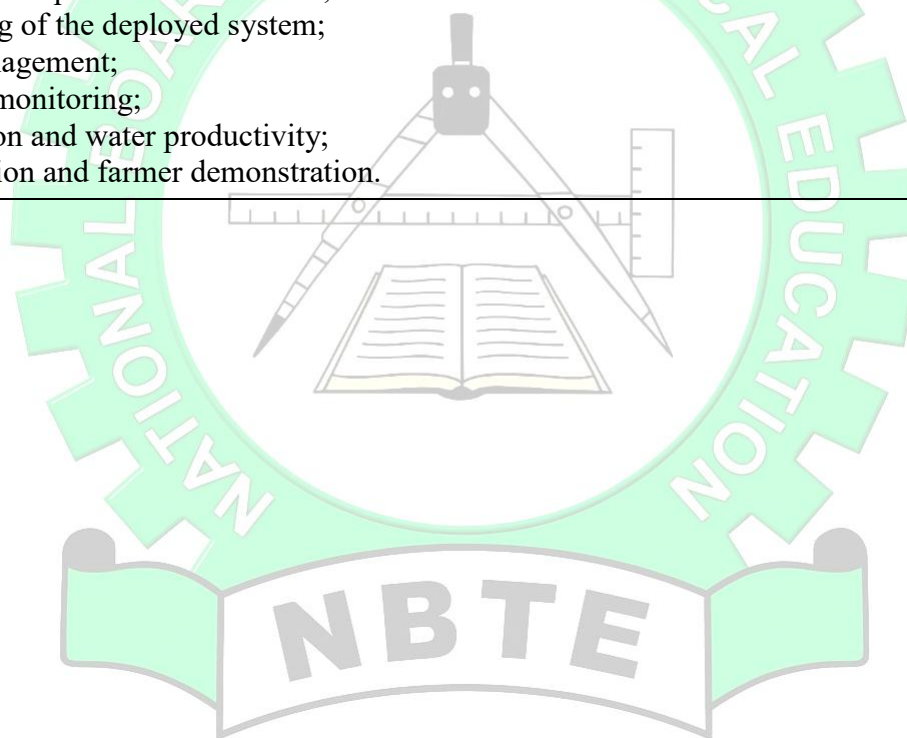
PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: IRRIGATION MAINTENANCE, REPAIR AND AUTOMATION SYSTEMS			COURSE CODE: IAT 216		CONTACT HOURS: 3 HOURS/WEEK	
			CREDIT UNIT: 3		THEORETICAL: 1 HOURS/WEEK	
YEAR: II SEMESTER: I			PRE-REQUISITE:		PRACTICAL: 2 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course covers maintenance, repair and basic automation of irrigation infrastructure both classical and smart systems.						
GENERAL OBJECTIVE 1.0: Understand preventive maintenance						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1-3	1.1 Describe daily, weekly, monthly and seasonal maintenance schedules 1.2 Explain function of lubrication, calibration and adjustment 1.3 Explain visual and instrument inspections 1.4 Explain maintenance documentation	- Describe daily, weekly, monthly and seasonal maintenance schedules - Explain function of lubrication, calibration and adjustment - Discuss visual and instrument inspections - Discuss maintenance documentation	Visual chart Diagrams, Model, Textbooks, Projector	- Develop a maintenance schedule for the demo systems - Lubricate, calibrate and adjust pumps, valves and sprinklers - Conduct visual and instrument inspections weekly - Maintain a maintenance logbook for 8 weeks	Guide students to - Develop a maintenance schedule for the demo systems - Lubricate, calibrate and adjust pumps, valves and sprinklers - Conduct visual and instrument inspections weekly - Maintain a maintenance logbook for 8 weeks	Demo systems, lubricants, inspection tools, logbooks
GENERAL OBJECTIVE 2.0: Understand pump and motor maintenance						
4-6	2.1 Explain pump-bearing and seal inspection 2.2 Explain motor and	- Explain bearing/seal inspection - Explain motor and	Visual chart Diagrams, Model,	- Inspect and replace a pump seal - Inspect motor	Guide student to: Supervise seal replacement	Pump, seals, electrical tools,

	electrical inspection 2.3 Describe pump-coupling alignment 2.4 Explain pump-impeller and casing repair	electrical inspection • Discuss pump-coupling alignment • Describe pump-impeller and casing repair	Textbooks, Projector	terminals and resistance • Align a pump-motor coupling • Inspect the impeller and repair minor damage	• Guide on electrical inspection • Conduct pump-coupling alignment Supervise pump-impeller and casing repair	alignment tools, impeller spares
GENERAL OBJECTIVE 3.0: Understand pipe and component repair						
7-9	3.1 Explain detection of leaks and bursts 3.2 Describe pipe-cutting, joining and threading 3.3 Explain gasket and seal replacement 3.4 Explain emitter and sprinkler maintenance	• Describe leakage detection methods • Explain pipe network for irrigation • Discuss gasket replacement • Describe emitter maintenance	Visual chart Diagrams, Model, Textbooks, Projector	• Detect leaks using visual and pressure-drop methods • Carry out cutting, threading and joining PVC and GI pipes • Replace 4 gaskets/seals across the demo systems • Replace 6 emitters and 4 sprinklers on demo systems	Guide student to: • Detect leaks using visual and pressure-drop methods • Carry out cutting, threading and joining PVC and GI pipes • Replace 4 gaskets/seals across the demo systems • Replace 6 emitters and 4 sprinklers on demo systems	Pipes, fittings, gaskets, emitters, sprinklers, tools
GENERAL OBJECTIVE 4.0: Understand automation and controller maintenance						
10-12	4.1 Explain controller / IoT-device inspection and update 4.2 Describe sensor recalibration and replacement 4.3 Explain firmware and software update procedures	• Describe the controller inspection device • Explain sensor maintenance • Discuss firmware and software update • Explain diagnostics for connectivity and power	Visual chart Diagrams, Model, Textbooks, Projector	• Inspect the demo IoT controller and clean contacts • Recalibrate the soil-moisture sensors • Perform a firmware update on the controller • Diagnose 3	Guide student to: • Inspect the demo IoT controller and clean contacts • Recalibrate the soil-moisture sensors • Perform a firmware update on the controller	Controllers, sensors, laptops, multimeters

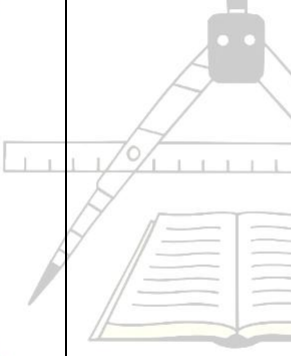
	4.4 Explain diagnostics for connectivity and power			connectivity / power issues and resolve them	•Diagnose 3 connectivity / power issues and resolve them	
GENERAL OBJECTIVE 5.0: Understand troubleshooting and asset management						
13-15	5.1 Explain systematic troubleshooting methodology 5.2 Explain spare-parts inventory and reorder levels 5.3 Describe asset register and depreciation tracking 5.4 Explain maintenance KPIs and reporting	• Discuss systematic troubleshooting • Discuss inventory and reorder levels • Discuss asset register • Explain maintenance KPIs and reporting	Visual chart Diagrams, Model, Textbooks, Projector	•Apply troubleshooting flowchart to 3 simulated faults •Build a spare-parts inventory with reorder levels •Build an asset register for the demo systems •Compute 4 maintenance KPIs over the semester	Guide student to: •Apply troubleshooting flowchart to 3 simulated faults •Build a spare-parts inventory with reorder levels •Build an asset register for the demo systems •Compute 4 maintenance KPIs over the semester	Flowcharts, inventory templates, KPI templates
COURSE ASSESSMENT: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

PRACTICAL IRRIGATION OPERATIONS II (SYSTEM DEPLOYMENT)

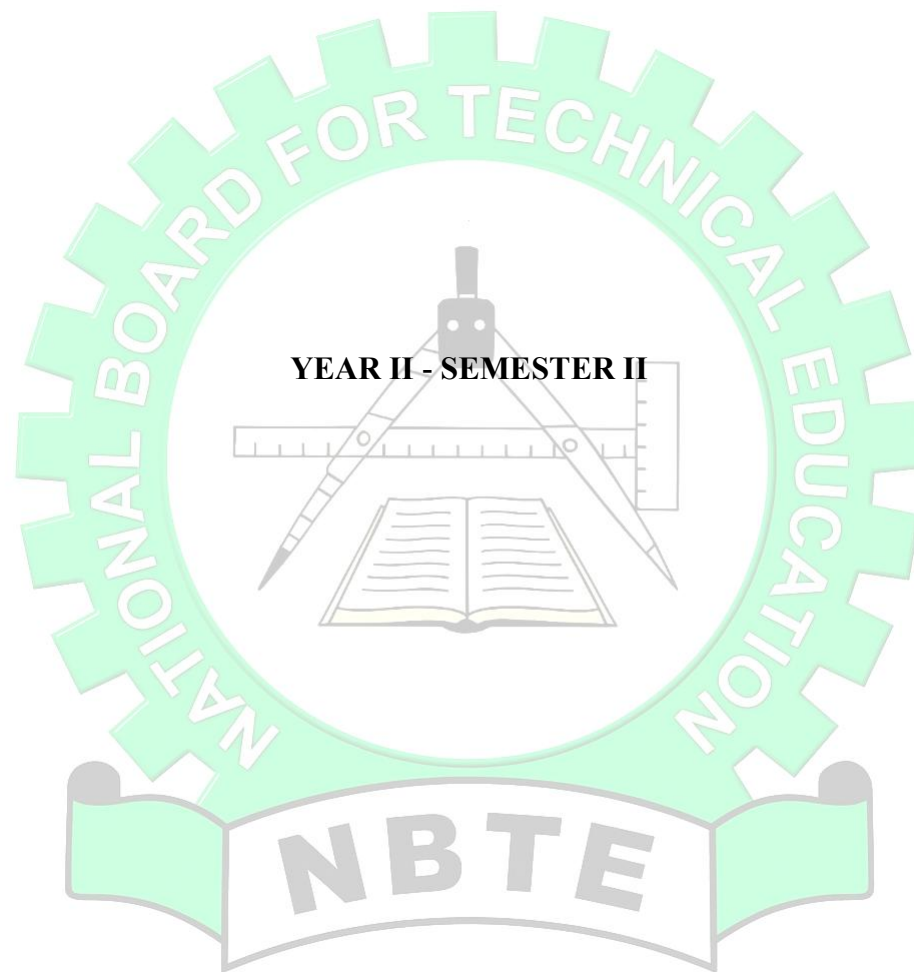
PROGRAMME: NATIONAL DIPLOMA (ND) IRRIGATION AGRONOMY TECHNOLOGY		
COURSE TITLE: PRACTICAL IRRIGATION OPERATIONS II (SYSTEM DEPLOYMENT)	COURSE CODE: IAT 217	CONTACT HOURS: 4 HOURS/WEEK
	CREDIT UNIT: 4	THEORETICAL: 0
YEAR: II SEMESTER: I	PRE-REQUISITE: IAT 126	PRACTICAL: 4 HOURS/WEEK
GOAL: This course is designed to equip students with skills in advanced field-practice course that deploys a complete irrigation system including smart features for a full crop cycle, with rigorous monitoring and evaluation.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand commissioning of the deployed system; 2.0 Know field-operation management; 3.0 know data collection and monitoring; 4.0 Understand yield evaluation and water productivity; 5.0 Know system documentation and farmer demonstration.		



PROGRAMME: NATIONAL DIPLOMA (ND) IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: PRACTICAL IRRIGATION OPERATIONS II (SYSTEM DEPLOYMENT)			COURSE CODE: IAT 217		CONTACT HOURS: 4 HRS/WEEK	
			CREDIT UNIT: 4		THEORETICAL: 0	
YEAR: II SEMESTER: I			PRE-REQUISITE: IAT 126		PRACTICAL: 4 HRS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with skills in advanced field-practice course that deploys a complete irrigation system including smart features for a full crop cycle, with rigorous monitoring and evaluation.						
GENERAL OBJECTIVE 1.0: Understand commissioning of the deployed system						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-2				•Verify all hydraulic components against design •Pressure-test the full network •Document results •Commission smart-irrigation components and sensors •Produce a commissioning certificate	Guide students to: •Verify all hydraulic components against design •Pressure-test the full network •Document results •Commission smart-irrigation components and sensors •Produce a commissioning certificate	Demo systems, pressure gauges, smart components, certificate templates
GENERAL OBJECTIVE 2.0: Know field-operation management						
3-8				•Operate the system to a published schedule for 8 weeks	Guide students to; •Operate the system to a published schedule for 8 weeks	Demo systems, fertilisers, log books, fault reports

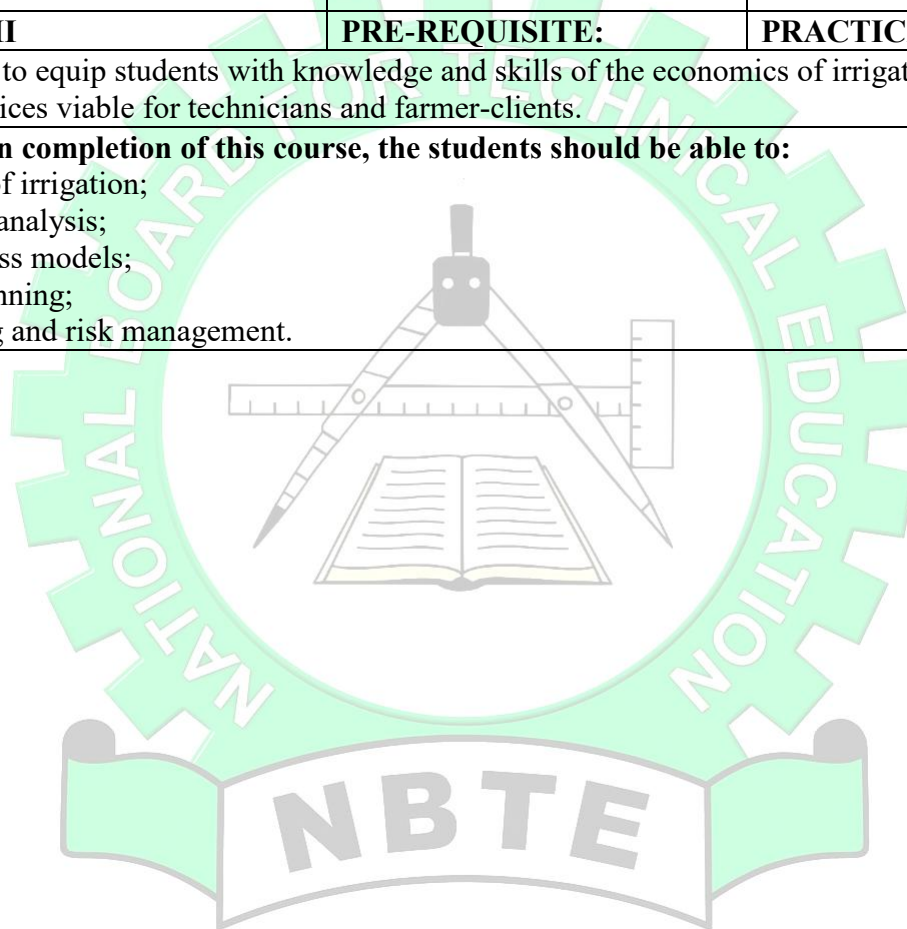
				•Apply daily and weekly maintenance •Manage fertigation and chemigation events •Manage at least 5 fault events •Document responses	•Apply daily and weekly maintenance •Manage fertigation and chemigation events •Manage at least 5 fault events •Document responses	
GENERAL OBJECTIVE 3.0: Know data collection and monitoring						
9-11				•Collect daily sensor data and ETo data •Record fertiliser, pesticide and labour inputs •Record crop growth and phenology weekly •Compile mid-cycle progress report	Guide students to; •Collect daily sensor data and ETo data •Record fertiliser, pesticide and labour inputs •Record crop growth and phenology weekly •Compile mid-cycle progress report	Sensors, weather station, log books, phenology charts
GENERAL OBJECTIVE 4.0: Understand yield evaluation and water productivity						
12-13				•Harvest the demo crop •Record yield •Compute water productivity (kg/m^3) for each subsystem •Compute economic metrics (gross margin, BCR)	Guide students to; •Harvest the demo crop •Record yield •Compute water productivity (kg/m^3) for each subsystem •Compute economic metrics (gross margin, BCR) •Compare across	Scales, calculators, comparison templates

				• Compare across subsystems and management practices	subsystems and management practices	
GENERAL OBJECTIVE 5.0: Know system documentation and farmer demonstration						
14-15				• Produce a 15-page final field-operations report • Produce as-built drawings and BoQ revisions • Host an open day for farmers and stakeholders • Compile lessons learned and improvement recommendations	Guide students to; • Produce a 15-page final field-operations report • Produce as-built drawings and BoQ revisions • Host an open day for farmers and stakeholders • Compile lessons learned and improvement recommendations	Report templates, drawing tools, farmer-invitation channels
COURSE ASSESSMENT: Course Assessment Course Assessment (Practical Based):10% Practical: 50% Examination (Practical Based): 40% Total: 100%						



IRRIGATION ENTERPRISE ECONOMICS AND FARM WATER BUSINESS MODELS

PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY		
COURSE TITLE: IRRIGATION ENTERPRISE ECONOMICS AND FARM WATER BUSINESS MODELS	COURSE CODE: IAT 221	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 of the economics of irrigation enterprises and the business models that make irrigation services viable for technicians and farmer-clients.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Know basic economics of irrigation; 2.0 Understand cost-benefit analysis; 3.0 Know farm water business models; 4.0 Understand business planning; 5.0 Know pricing, marketing and risk management.		



PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: IRRIGATION ENTERPRISE ECONOMICS AND FARM WATER BUSINESS MODELS			COURSE CODE: IAT 221		CONTACT HOURS: 3 HOURS/WEEK	
			CREDIT UNIT: 2		THEORETICAL: 1 HOUR/WEEK	
YEAR: II SEMESTER: II			PRE-REQUISITE:		PRACTICAL: 2 HOURS/WEEK	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills of the economics of irrigation enterprises and the business models that make irrigation services viable for technicians and farmer-clients.						
GENERAL OBJECTIVE 1.0: Know basic economics of irrigation						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1 – 3	1.1 Define fixed and variable costs in irrigation 1.2 Explain the concept of opportunity cost in water use 1.3 Describe discounting and the time value of money 1.4 Distinguish between private and social returns to irrigation	• Explain fixed and variable costs in irrigation • Discuss opportunity cost in water use • Explain discounting and the time value of money • Explain private and social returns to irrigation	Visual chart Diagrams, Model, Textbooks, Projector	• Tabulate fixed and variable costs for a 1-ha drip system. • Compute opportunity cost of water in 2 alternative uses. • Compute NPV of a 5-year irrigation investment. • Compare private and social returns for one case study	Guide students to; • Tabulate fixed and variable costs for a 1-ha drip system. • Compute opportunity cost of water in 2 alternative uses. • Compute NPV of a 5-year irrigation investment. • Compare private and social returns for one case study	Calculators, Cost data, NPV templates
GENERAL OBJECTIVE 2.0: Understand cost-benefit analysis						
4-6	2.1 Describe payback period and break-even analysis 2.2 Explain net present value (NPV) and benefit-cost ratio	• Explain payback period and break-even analysis • Discuss NPV/BCR • Explain IRR • Describe sensitivity	Visual chart Diagrams, Model, Textbooks, Projector	• Compute payback period for irrigation investment • Compute NPV and BCR for the same investment	Guide students to; • Compute payback period for irrigation investment • Compute NPV and BCR for the same	Spreadsheets, sample financial data, sensitivity templates

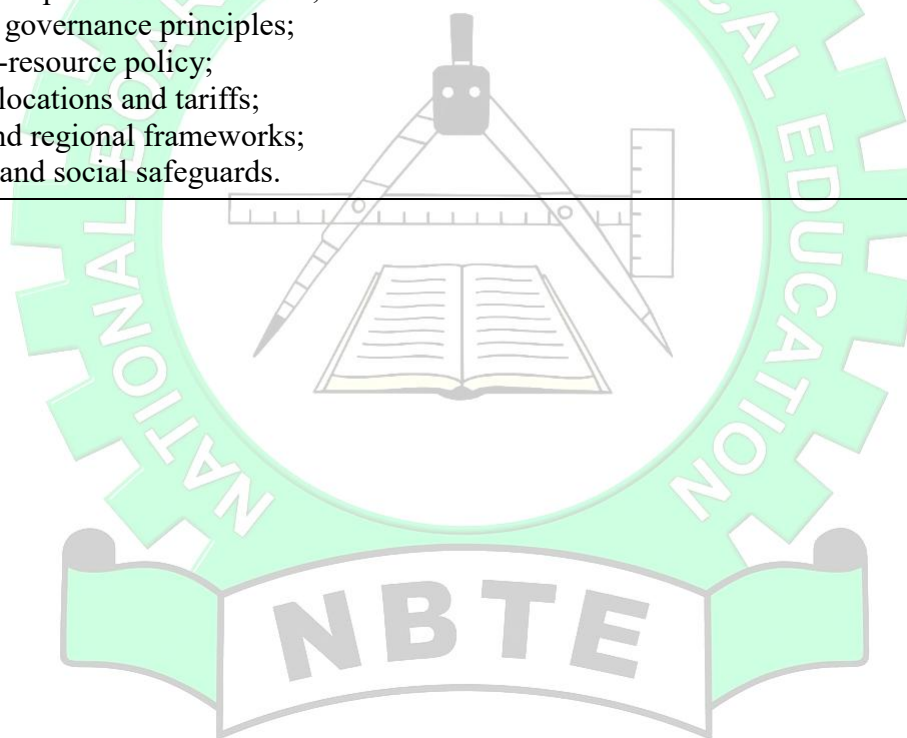
	(BCR) 2.3 Explain internal rate of return (IRR) 2.4 Explain sensitivity analysis	analysis		• Compute IRR using a spreadsheet • Run a sensitivity analysis on water price and yield	investment • Compute IRR using a spreadsheet • Run a sensitivity analysis on water price and yield	
GENERAL OBJECTIVE 3.0: Know farm water business models						
7 – 8	3.1 Explain business models: pay-per-use, leasing, custom hiring 3.2 Explain service-based models (irrigation as a service, IaaS) 3.3 Explain community-irrigation business models 3.4 Describe smart-irrigation-as-a-service models	• Describe business models: pay-per-use, leasing, custom hiring • Discuss service-based models (irrigation as a service, IaaS) • Describe community-irrigation business models • Explain smart-irrigation-as-a-service models	Visual chart Diagrams, Model, Textbooks, Projector	• Map 3 pay-per-use schemes operating in Nigeria • Design a leasing model for sprinkler equipment • Design a community-irrigation business model • Design a smart-irrigation as a service model	Guide students to; • Map 3 pay-per-use schemes operating in Nigeria • Design a leasing model for sprinkler equipment • Design a community-irrigation business model • Design a smart-irrigation as a service model	Business case studies, Design templates
GENERAL OBJECTIVE 4.0: Understand business planning						
9 – 11	4.1 Explain Business Model Canvas 4.2 Explain business-plan structure 4.3 Describe financial projections (3-year) 4.4 Explain funding sources (BoI, BoA, microfinance, grants)	• Discuss BMC • Explain business plan structure • Discuss financial projections • Discuss funding sources	Visual chart Diagrams, Model, Textbooks, Projector	• Build a BMC for a chosen irrigation business model • Write a 10-page business plan • Build a 3-year financial projection • Identify 3 funding sources for the proposed enterprise	Guide students to; • Build a BMC for a chosen irrigation business model • Write a 10-page business plan • Build a 3-year financial projection • Identify 3 funding sources for the proposed enterprise	BMC templates, Plan templates, Financial models

GENERAL OBJECTIVE 5.0: Understand pricing, marketing and risk management

12 – 15	5.1 Discuss pricing strategies for irrigation services 5.2 Explain marketing strategies (digital, B2B, community-based) 5.3 Discuss risk identification and mitigation 5.4 Explain insurance and contingency planning	• Explain pricing strategies for irrigation services • Discuss marketing strategies • Explain risk and mitigation • Discuss insurance and contingency planning	Visual chart Diagrams, Model, Textbooks, Projector	• Design a pricing structure for one irrigation service • Build a marketing plan including digital and B2B channels • Build a risk register with 10 risks and mitigations • Identify insurance and contingency options	Guide students to: • Design a pricing structure for one irrigation service • Build a marketing plan including digital and B2B channels • Build a risk register with 10 risks and mitigations • Identify insurance and contingency options	Pricing templates, Marketing templates, Risk register templates
COURSE ASSESSMENT: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

WATER RESOURCE GOVERNANCE AND POLICY IN AGRICULTURE

PROGRAMME: NATIONAL DIPLOMA (ND) IRRIGATION AGRONOMY TECHNOLOGY		
COURSE TITLE: WATER RESOURCE GOVERNANCE AND POLICY IN AGRICULTURE	COURSE CODE: IAT 222	CONTACT HOURS: 3 HOURS/WEEK
	CREDIT UNIT: 3	THEORETICAL: 1 HOUR/WEEK
YEAR: II SEMESTER: II	PRE-REQUISITE: NIL	PRACTICAL: 2 HOURS/WEEK
GOAL: This course is designed to equip students with knowledge and skills to examine governance, policy and regulatory framework governing water use in Nigerian agriculture, with attention to climate, equity, and sustainability.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand water-resource governance principles; 2.0 Understand Nigerian water-resource policy; 3.0 Understand water rights, allocations and tariffs; 4.0 Understand international and regional frameworks; 5.0 Understand environmental and social safeguards.		



PROGRAMME: NATIONAL DIPLOMA (ND) IRRIGATION AGRONOMY TECHNOLOGY**COURSE TITLE: WATER RESOURCE GOVERNANCE AND POLICY IN AGRICULTURE****COURSE CODE: IAT 222****CONTACT HOURS: 3 HOURS/WEEK****CREDIT UNIT: 3****THEORETICAL: 1 HOUR/WEEK****YEAR: II SEMESTER: II****PRE-REQUISITE: NIL****PRACTICAL: 2 HOURS/WEEK****COURSE SPECIFICATION: THEORETICAL AND PRACTICAL**

GOAL: This course is designed to equip students with knowledge and skills to examine governance, policy and regulatory framework governing water use in Nigerian agriculture, with attention to climate, equity, and sustainability.

GENERAL OBJECTIVE 1.0: Understand water-resource governance principles.

THEORETICAL CONTENT**PRACTICAL CONTENT**

Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Define water-resource governance and its actors 1.2 Explain integrated water resource management (IWRM) 1.3 Explain principles of equity, efficiency and sustainability 1.4 Describe public-private-community partnerships	• Explain water-resource governance and its actors • Discuss integrated water resource management (IWRM) • Discuss principles of equity, efficiency and sustainability • Explain public-private-community partnerships	Textbooks, Projector, Whiteboard, flip charts, and markers E-Library	• Maps Governance actors for one river basin • Apply IWRM principles to a case scenario • Score the equity, efficiency, and sustainability of a chosen scheme • Document a partnership model	Guide students to: • Maps Governance actors for one river basin • Apply IWRM principles to a case scenario • Score the equity, efficiency, and sustainability of a chosen scheme • Document a partnership model	Water Maps, Case studies of water governance in Nigeria Government agency reports and publications Multimedia presentations on water governance and structures

GENERAL OBJECTIVE 2.0: Understand Nigerian water-resource policy

4-6	2.1 Explain the National Water Resources Policy. 2.2 Explain the Federal Ministry of Water Resources, NIWRMC, NIHSA, RBDAs 2.3 Explain state-level water laws and the Land Use Act 2.4 Outline the National Irrigation Policy / Master Plan	• Discuss the National Water Resources Policy. • Discuss the Federal Ministry of Water Resources, NIWRMC, NIHSA, RBDAs • Explain state-level water laws and the Land Use Act • Discuss the National Irrigation Policy / Master Plan	Textbooks, Projector Whiteboard, flip charts, and markers E-Library	• Read and summarize the NWRP. • Browse the websites of NIWRMC, NIHSA, RBDAs • Compare 2 state water laws. • Summarise the National Irrigation Master Plan.	Guide students to: • Read and summarize the NWRP. • Browse the websites of NIWRMC, NIHSA, RBDAs • Compare 2 state water laws. • Summarise the National Irrigation Master Plan.	Policy documents, internet, comparison templates
GENERAL OBJECTIVE 3.0: Understand water rights, allocations and tariffs						
7-9	3.1 Explain water-rights concepts 3.2 Describe water-allocation processes (RBDA, irrigation district) 3.3 Explain water-tariff structures 3.4 Explain dispute-resolution mechanisms	• Explain water-rights concepts • Discuss water-allocation processes (RBDA, irrigation district) • Explain water-tariff structures • Discuss dispute-resolution mechanisms	Textbooks, Projector Whiteboard, flip charts, and markers E-Library	• Apply hypothetical irrigation water right • Trace an allocation process from a chosen RBDA • Tabulate tariff structures from 2 RBDAs • Simulate a water-dispute resolution meeting	Guide the students to: • Apply hypothetical irrigation water right • Trace an allocation process from a chosen RBDA • Tabulate tariff structures from 2 RBDAs • Simulate a water-dispute resolution	• Visit any nearby RBDAs • Application forms. • Allocation case data, \ simulation scripts

GENERAL OBJECTIVE 4.0: Understand international and regional frameworks

10-12	4.1 Describe transboundary water management (Niger Basin, Lake Chad Basin) 4.2 Explain SDG 6 (clean water and sanitation) 4.3 Explain UNFCCC and NDC commitments on water 4.4 Explain regional bodies (ECOWAS, AU) and irrigation	• Explain transboundary water management (Niger Basin, Lake Chad Basin) • Describe SDG 6 (clean water and sanitation) • Discuss UNFCCC and NDC commitments on water • Explain regional bodies (ECOWAS, AU) and irrigation	Textbooks, Projector Whiteboard, flip charts, and markers E-Library	• Map Niger / Lake Chad basin sharing arrangements • Map SDG 6 indicators for Nigeria • Summaries water content of Nigeria's NDC • Browse ECOWAS / AU water-related publications	Guide the student to; • Map Niger / Lake Chad basin sharing arrangements • Map SDG 6 indicators for Nigeria • Summaries water content of Nigeria's NDC • Browse ECOWAS / AU water-related publications	Political and hydrological maps of West Africa and Africa Niger Basin and Lake Chad Basin maps Atlas and globe GIS software and satellite imagery River basin management reports and case studies Multimedia projector and computer Documentary videos on shared water resources
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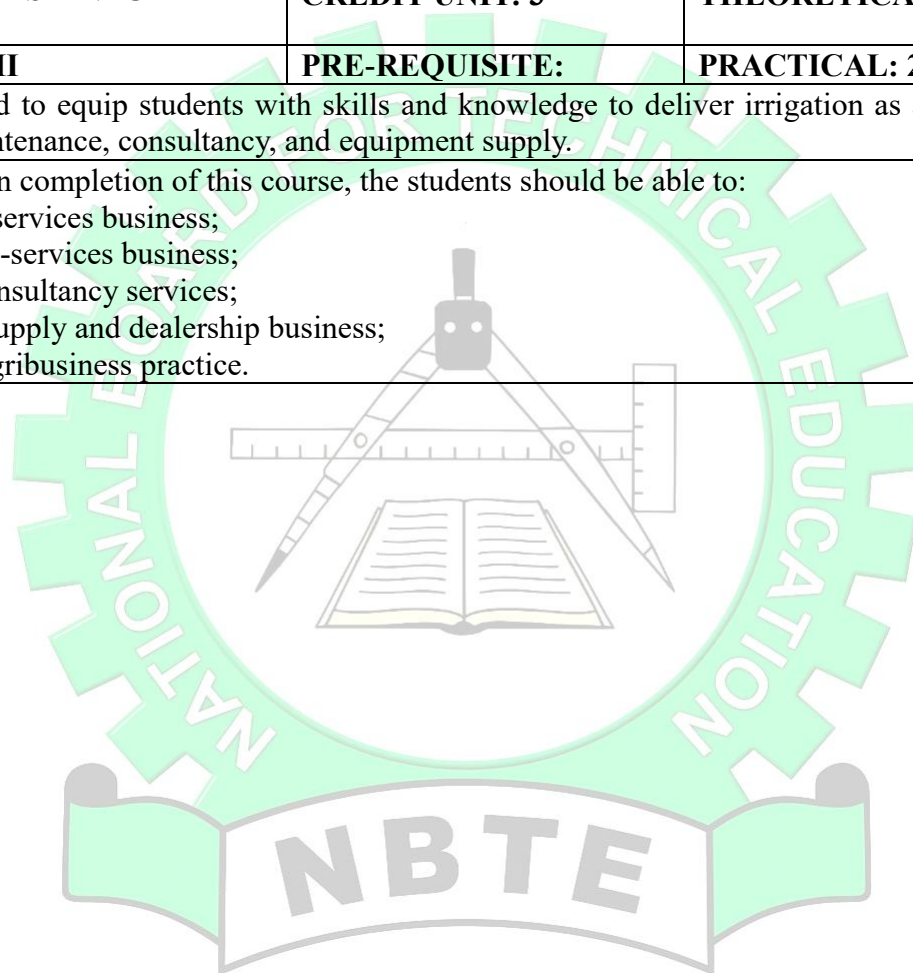
GENERAL OBJECTIVE 5.0: Understand environmental and social safeguards

13-15	5.1 Explain Environmental Impact Assessment (EIA) for irrigation projects	• Explain Environmental Impact Assessment (EIA) for irrigation projects	Textbooks, Projector Whiteboard, flip charts, and markers	• Conduct a scoping EIA for a hypothetical	Guide the student to; • Conduct a scoping EIA for a hypothetical irrigation scheme • Apply social-safeguard	EIA templates, checklists, report templates
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	5.2 Discuss social safeguards (gender, livelihoods, displacement) 5.3 Explain climate safeguards in irrigation policy 5.4 Explain data and reporting obligations	• Discuss social safeguards (gender, livelihoods, displacement) • Explain climate safeguards in irrigation policy • Apply data and reporting obligations	E-Library	irrigation scheme • Apply social-safeguard checklist • Apply climate-safeguard checklist • Prepare a policy-compliance report	checklist • Apply climate-safeguard checklist • Prepare a policy-compliance report	
COURSE ASSESSMENT: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

AGRIBUSINESS OF IRRIGATION SYSTEMS AND SERVICE DELIVERY

PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY		
COURSE TITLE: AGRIBUSINESS OF IRRIGATION SYSTEMS AND SERVICE DELIVERY	COURSE CODE: IAT 223	CONTACT HOURS: 4 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 skills and knowledge to deliver irrigation as a commercial service, covering system installation, routine maintenance, consultancy, and equipment supply.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand installation-services business; 2.0 Understand maintenance-services business; 3.0 Understand irrigation consultancy services; 4.0 Understand equipment supply and dealership business; 5.0 Understand integrated agribusiness practice.		



PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: AGRIBUSINESS OF IRRIGATION SYSTEMS AND SERVICE DELIVERY			COURSE CODE: IAT 224		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 skills and knowledge to deliver irrigation as a commercial service, covering system installation, routine maintenance, consultancy, and equipment supply.						
GENERAL OBJECTIVE 1.0: Understand installation-services business.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1- 3	1.1 Explain customer needs assessment. 1.2 Describe quotation, contracting and scope of work. 1.3 Explain project execution and quality management. 1.4 Describe post-installation handover and training.	• Discuss needs assessment. • Explain quotation, contracting and scope of work quotations. • Discuss project execution and quality management. • Describe Handover procedures.	Service-business templates, Textbooks, Projector Whiteboard, flip charts, and markers	• Conduct needs assessment for a hypothetical farmer-client demand. • Prepare a quotation and scope-of-work. • Execute an installation project on the demo field (mini-scale). • Conduct handover and basic training of a mock client.	Guides students to: • Conduct needs assessment for a hypothetical farmer-client demand. • Prepare a quotation and scope-of-work. • Execute an installation project on the demo field (mini-scale). • Conduct handover and basic training of a mock client.	Assessment templates, Quotation templates, Demo field, Mock clients
GENERAL OBJECTIVE 2.0: Understand maintenance-services business						
4 – 6	2.1 Explain maintenance-contract structures (per-call, AMC, performance).	• Discuss types of contracts. • Describe call-out procedures.	Service-business templates, Textbooks,	• Develop 3 Draft maintenance-contract templates. • Simulate a call-out	Guide students to: • Develop 3 Draft maintenance-contract templates.	Contract templates, Simulation scripts, Logistics

	2.2 Explain call-out and response procedures. 2.3 Explain spare-parts logistics. 2.4 Explain customer relationship management (CRM).	• Discuss spare part logistics. • Describe CRM.	Projector Whiteboard, flip charts, and markers	and response procedures. • Build a spare-parts logistics plan. • Set up a basic CRM in spreadsheet or or CRM app.	• Simulate a call-out and response procedures. • Build a spare-parts logistics plan. • Set up a basic CRM in spreadsheet or or CRM app.	templates, CRM tools.
GENERAL OBJECTIVE 3.0: Understand irrigation consultancy services.						
7 – 9	3.1 Explain pre-feasibility / feasibility studies. 3.2 Describe design and supervisory consultancy. 3.3 Explain training and capacity-building services. 3.4 Describe monitoring and evaluation services.	• Describe pre-feasibility/ feasibility studies. • Discuss design and supervisory consultancy. • Discuss training and capacity-building services. • Describe an MandE framework.	Service-business templates, Textbooks, Projector Whiteboard, flip charts, and markers	• Conduct a pre-feasibility for a 0.5-ha plot. • Provide a design-only consultancy package. • Plan a 3-day farmer-training programme. • Build an MandE framework for an existing scheme.	Guide students to: • Conduct a pre-feasibility for a 0.5-ha plot. • Provide a design-only consultancy package. • Plan a 3-day farmer-training programme. • Build an MandE framework for an existing scheme.	Feasibility templates, Design samples, Training templates, MandE templates, Consultancy guides,
GENERAL OBJECTIVE 4.0: Understand equipment supply and dealership business						
10 – 12	4.1 Explain supplier sourcing and quality assurance. 4.2 Describe inventory management. 4.3 Explain distribution and logistics in	• Discuss supply sourcing and quality assurance. • Explain inventory management. • Discuss distribution and logistics in businesses.	Service-business templates, Textbooks, Projector Whiteboard, flip charts,	• Map 5 suppliers of irrigation equipment in Nigeria. • Build an inventory-management system in spreadsheet. • Plan distribution	Guide students to: • Map 5 suppliers of irrigation equipment in Nigeria. • Build an inventory-management system in spreadsheet. • Plan distribution routes for a	Supplier directories, Inventory templates, Distribution maps, Warranty templates, Supply-chain

	businesses. 4.4 Explain warranty and after-sales support services.	• Discuss warranty and after-sales support.	and markers	routes for a dealership. • Draft warranty terms and after-sales Standard Operating Procedure (SOP).	dealership. • Draft warranty terms and after-sales Standard Operating Procedure (SOP).	manuals,
GENERAL OBJECTIVE 5.0: Understand integrated agribusiness practice.						
13 – 15	5.1 Describe value-chain analysis for irrigation services. 5.2 Explain cluster / cooperative business models. 5.3 Explain digital marketing and online presence. 5.4 Describe methods of registration, taxation and compliance of business entity.	• Describe value chain analysis • Describe cluster models. • Explain digital marketing. • Explain business registration procedures and compliance.	Service-business templates, Textbooks, Projector Whiteboard, flip charts, and markers	• Map the irrigation services value chain. • Design a cluster / cooperative model. • Build a basic website and social-media presence. • Register a hypothetical business with corporate Affairs Commission (CAC) and tax authorities.	Guide students to: • Map the irrigation services value chain. • Design a cluster / cooperative model. • Build a basic website and social-media presence. • Register a hypothetical business with corporate Affairs Commission (CAC) and tax authorities.	Value-chain templates, Business design templates, Website builders, CAC forms.
COURSE ASSESSMENT: Course work: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

CLIMATE RISK ANALYSIS IN IRRIGATION PLANNING

PROGRAMME: NATIONAL DIPLOMA (ND) IRRIGATION AGRONOMY TECHNOLOGY		
COURSE TITLE: CLIMATE RISK ANALYSIS IN IRRIGATION PLANNING	COURSE CODE: IAT 224	CONTACT HOURS: 4HOURS/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 knowledge and skills on climate-risk-analysis tools to irrigation planning, enabling technicians to identify, assess and manage climate risks for irrigation projects.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the fundamental concepts of climate change, climate variability, and their specific impacts on Nigerian agriculture; 2.0 Know meteorological and hydrological datasets to forecast irrigation water demand and supply; 3.0 Know physical, economic, and environmental climate risks affecting irrigation infrastructures; 4.0 Understand climate-smart irrigation technologies and adaptive agronomic practices at the farm level; 5.0 Know the formulation localized climate risk mitigation and water management plans for smallholder farmer clusters.		

PROGRAMME: NATIONAL DIPLOMA (ND) IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: CLIMATE RISK ANALYSIS IN IRRIGATION PLANNING			COURSE CODE: IAT 224		CONTACT HOURS: 4HOURS/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 knowledge and skills on climate-risk-analysis tools to irrigation planning, enabling technicians to identify, assess and manage climate risks for irrigation projects.						
GENERAL OBJECTIVE 1.0: Understand climate-risk concepts and frameworks.						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Define climate, weather, climate variability and climate change concepts. 1.2 Describe climate hazards affecting irrigation systems. 1.3 Discuss sources of climate data. 1.4 Explain meteorological observations. 1.5 Discuss climate information databases. 1.6 Describe rainfall records and	● Explain climate concepts using Nigerian examples. ● Discuss climate impacts on irrigation agriculture. ● Discuss climate data sources ● Outline meteorological instruments. ● Describe rainfall analysis procedures and statistical methods.	Projector, Climate maps, Lecture notes, Climate reports Weather station manuals, Internet facilities, Computers. Rainfall records, Spreadsheets, Meteorological data.	● Identify climate hazards affecting irrigation schemes within local communities. ● Collect climate data from weather stations and online databases. ● Plot rainfall graphs and analyze rainfall trends.	Guide students in: ● Identify climate hazards affecting irrigation schemes within local communities. ● Collect climate data from weather stations and online databases. ● Plot rainfall graphs and analyze rainfall trends.	Community maps, Field notebooks. Weather instruments, Internet access. Computers, Spreadsheet, Software.

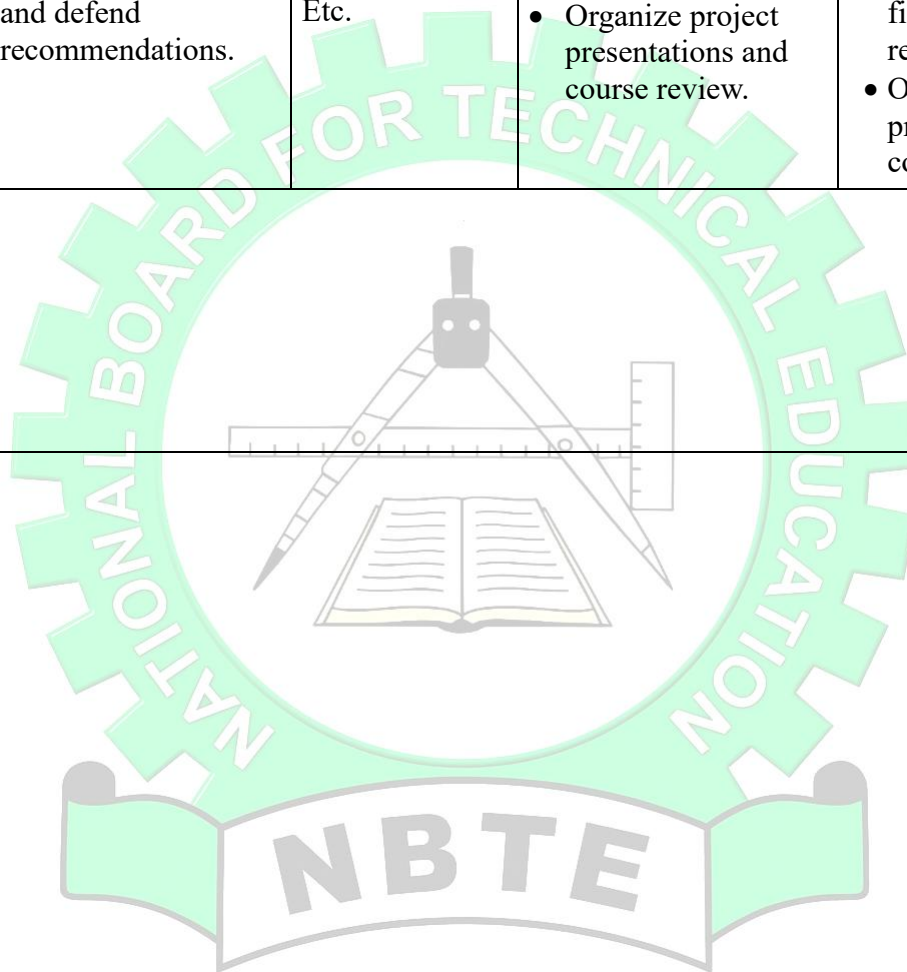
	determine rainfall variability. 1.7 Discuss rainfall trends for irrigation planning.					
GENERAL OBJECTIVE 2.0: Know meteorological and hydrological datasets to forecast irrigation water demand and supply.						
4-6	2.1 Describe temperature records and estimate evapotranspiration. 2.2 Explain the relation ET to crop water requirements. 2.3 Explain drought and assess drought severity using standard indicators. 2.4 Describe flood hazards and assess flood impacts on irrigation infrastructure.	• Explain temperature records and estimate evapotranspiration • Describe the relation ET to crop water requirements. • Explain drought and assess drought severity using standard indicators. • Discuss flood hazards and assess flood impacts on irrigation infrastructure.	Temperature records, ET charts, Calculators. Drought index charts, Climate reports. Flood maps, Case studies, GIS maps	• Calculate evapotranspiration and crop water requirements. • Compute drought severity indicators and interpret results. • Prepare flood hazard maps and identify vulnerable irrigation infrastructure.	Guide students to: • Calculate ET and irrigation scheduling exercises. • Carryout drought index calculations. • Carryout flood mapping exercises.	Calculators, ET data sheets. Drought datasets, calculators. GIS software, flood maps.
GENERAL OBJECTIVE 3.0 Know physical, economic, and environmental climate risks affecting irrigation infrastructures						
7-9	4.1 Explain climate vulnerability and exposure concepts. 4.2 Explain adaptive capacity. 4.3 Explain climate	• Explain vulnerability assessment frameworks. • Describe risk matrix	Vulnerability assessment manuals, LCD projector. Risk matrix templates,	• Conduct vulnerability assessments of selected irrigation schemes. • Develop	Guide students to: • Conduct vulnerability assessments of selected irrigation schemes.	Survey forms, GPS receivers Risk matrix templates. GIS software, GPS units.

	risk matrices and prioritize climate hazards. 4.4 Explain GIS principles and applications in climate risk analysis.	development and facilitate classroom exercises. • Describe GIS operations and spatial data management.	Flip charts. GIS laboratory, computers, GIS software	climate risk matrices and prioritize identified risks. • Produce GIS-based climate hazard maps.	• Develop climate risk matrices and prioritize identified risks. • Produce GIS-based climate hazard maps.	
GENERAL OBJECTIVE 4.0: Understand climate-smart irrigation technologies and adaptive agronomic practices at the farm level						
10-12	4.1 Explain remote sensing principles and applications in irrigation planning. 4.2 Explain climate-smart irrigation technologies and evaluate their performance. 4.3 Explain water harvesting principles and estimate storage requirements.	• Explain image interpretation and vegetation monitoring techniques. • Explain the operation and efficiency of irrigation systems. • Describe water harvesting structures and calculations.	Satellite imagery, Remote sensing software Drip kits, Sprinkler systems, Videos Design manuals, Models, Charts Etc.	• Interpret satellite imagery and identify vegetation and moisture conditions. • Evaluate the efficiency of drip and sprinkler irrigation systems. • Design water harvesting structures and estimate storage capacities.	Guide students to: • Interpret satellite imagery and identify vegetation and moisture conditions. • Evaluate the efficiency of drip and sprinkler irrigation systems. • Design water harvesting structures and estimate storage capacities.	Satellite imagery, Remote sensing software Irrigation demonstration field, Design sheets, calculators
GENERAL OBJECTIVE 5.0: Know the formulation of localized climate risk mitigation and water management plans for smallholder farmer clusters.						
13-15	5.1 Explain adaptation and mitigation strategies for climate-resilient irrigation. 5.2 Explain climate risk	• Describe adaptation and mitigation strategies for climate-resilient irrigation. • Discuss climate risk assessments and	Climate-smart agriculture Manuals Project Field guides, Survey forms	• Develop climate adaptation plans for irrigation projects. • Conduct field climate risk assessments and	Guide students to: • Develop climate adaptation plans for irrigation projects. • Conduct field climate risk	Reporting templates, Audience, decision tools, KPI templates.

	assessments and prepare technical reports. 5.3 Outline climate risk assessment findings and defend recommendations.	prepare technical reports. • Discuss climate risk assessment findings and defend recommendations.	Multimedia projector, Presentation templates Etc.	collect technical data. • Prepare and present field project reports. • Organize project presentations and course review.	assessments and collect technical data. • Prepare and present field project reports. • Organize project presentations and course review.	
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COURSE ASSESSMENT:

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



SOIL AND WATER CONSERVATION

PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY		
COURSE TITLE: SOIL AND WATER CONSERVATION	COURSE CODE: IAT 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 the knowledge and skills required to manage soil and water conservation principles and practices for sustainable irrigated agriculture.		
General Objective: On completion of this course, students should be able to: 1.0 Understand the importance of soil and water conservation in irrigation; 2.0 Know the various methods of soil and water conservation and their limitations; 3.0 Understand the importance of hydrology and meteorology to soil and water conservation; 4.0 Understand the basic principles and practices of erosion control; 5.0 Understand the factors that cause land degradation; 6.0 Understand land Management, conservation and reclamation using various methods.		

PROGRAMME: NATIONAL DIPLOMA IN IRRIGATION AGRONOMY TECHNOLOGY						
COURSE TITLE: SOIL AND WATER CONSERVATION			COURSE CODE: IAT 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 the knowledge and skills required to manage soil and water conservation principles and practices for sustainable irrigated agriculture.						
General Objective 1.0: Understand the importance of soil and water conservation in irrigation						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher’s Activities	Resources	Specific Learning Outcome	Teacher’s Activities	Resources
1 – 3	1.1 Define soil conservation. 1.2 Define water conservation. 1.3 Explain ways irrigated crop production can be increased through soil conservation practices. 1.4 Describe challenges affecting successful soil and water conservation in the field. 1.5 Explain the objectives of soil and water conservation. 1.6 Explain relationship between irrigation and conservation. 1.7 Describe sustainability concepts.	• Explain soil conservation. • Describe water conservation. • Explain ways irrigated crop production can be increased through soil conservation practices. • Describe challenges affecting successful soil and water conservation in the field. • Explain the objectives of soil and water conservation. • Explain relationship between irrigation and conservation. • Describe	Whiteboard, marker, Whiteboard, Charts, Projector Computer, Marker, Lecture notes, Multimedia .	• Identify visible conservation problems in irrigated fields. • Observe effects of poor conservation practices. • Conduct Watershed mapping exercise.	Guide students to: • Identify visible conservation problems in irrigated fields. • Observe effects of poor conservation practices. • Conduct Watershed mapping exercise.	Farm plots, Camera, notebook Demonstration plots, Soil samples Satellite maps

		sustainability concepts.				
General Objective 2.0: Know the various methods of soil and water conservation and their limitations						
4 - 6	2.1 Describe mechanical conservation methods. 2.2 Explain agronomic conservation methods. 2.3 Outline biological conservation measures. 2.4 Explain contour farming. 2.5 Explain strip cropping. 2.6 Explain mulching and cover cropping. 2.7 Explain terracing methods. 2.8 Explain limitations of conservation methods. 2.2 Explain methods for different terrains.	• Explain mechanical conservation methods. • Describe agronomic conservation methods. • Discuss biological conservation measures. • Explain contour farming. • Describe strip cropping. • Explain mulching and cover cropping. • Explain terracing methods. • Discuss limitations of conservation methods. • Discuss methods for different terrains.	Laptop Smartboard, Projector, Markers, Internet Models, Conservation structures Diagrams Videos, Charts	• Visit affected sites with terraces, swales, check dams, sand dams, etc. • Identify conservation structures in field. • Practice contour layout and mulching. • Construct simple contour bunds. • Demonstrate techniques	Guide students on: • Visit affected sites with terraces, swales, check dams, sand dams, etc. • Identify conservation structures in field. • Practice contour layout and mulching. • Construct simple contour bunds. • Demonstrate techniques.	Field structures, Measuring tapes, Mulch Samples .
General Objective 3.0: Understand the importance of hydrology and meteorology to soil and water conservation						
7 – 8	3.1 Define hydrology. 3.2 Describe the hydrologic cycle. 3.3 Explain watershed concepts. 3.4 Describe meteorological data and its importance in	• Explain hydrology. • Explain the hydrologic cycle. • Describe watershed concepts. • Describe meteorological data and its importance in	Laptop Projector, Whiteboard, marker Charts, Models Rainfall records	• Identify watershed features. • Field mapping exercise. • Installation of simple gauges • Measure climatic variables.	Guide students to: • Identify watershed features. • Field mapping exercise. • Installation of simple gauges	Maps, GPS Rain gauge, Hygrometer, Anemometer , Evaporation pan, Barometer,

	soil and water conservation. 3.5 Outline how to take meteorological readings using the rain gauges, anemometer, thermometer, psychrometer, etc. 3.6 Explain how to calculate the monthly and annual mean value of climatic variables. 3.7 Explain rainfall characteristics. 3.8 State climate influence on irrigation. 3.9 Explain runoff and hydrograph analysis and determine the return period. 3.10 Explain infiltration processes 3.11 Describe Water Balance Equation.	soil and water conservation. • Explain how to take meteorological readings using the rain gauges, anemometer, thermometer, psychrometer, etc. • Outline how to calculate the monthly and annual mean value of climatic variables. • Explain rainfall characteristics. • State climate influence on irrigation. • Explain runoff and hydrograph analysis and determine the return period. • Explain infiltration processes • Describe Water Balance Equation.	Worksheets Internet Pictures Calculators	• Conduct infiltration tests. • Demonstrate procedures.	• Measure climatic variables. • Conduct infiltration tests. • Demonstrate procedures.	Solarimeter Double-ring infiltrometer, thermometer
General Objective 4.0: Understand the basic principles and practices of erosion control						
9 – 11	4.1 Define erosion. 4.2 Discuss types of erosion. 4.3 Discuss causes of erosion. 4.4 Explain erosion processes.	• Discuss erosion • Explain types of erosion. • Identify causes of erosion. • Describe. erosion processes.	Laptop Smart board, Projector, White board, Markers, Internet, Charts,	• Identify erosion forms in field. • Estimate soil loss indicators. • Construct simple erosion control structures.	Guide students to: • Identify erosion forms in field. • Estimate soil loss indicators. • Construct simple erosion control	Field sites Soil sampling tools Sand bags Models, Grasses

	4.5 Discuss erosion hazards in irrigated agriculture. 4.6 Explain sediment transport. 4.7 Explain erosion control methods 4.8 Describe gully control measures 4.9 Discuss vegetative control measures	● Explain erosion hazards in irrigated agriculture. ● Discuss sediment transport. ● Explain erosion control methods ● Explain gully erosion control measures. ● Explain vegetative cover control measures.	Models Video clips, Pictures, Marker Projector, Diagrams		structures.	
General Objective 5.0: Understand the factors that cause land degradation						
12-13	5.1 Define land degradation. 5.2 Explain causes of land degradation. 5.4 Explain the ways by which land degradation process could lead to reduction in crop productivity. 5.5 Discuss the effect of Overgrazing, bush burning, erosion, excessive lumbering, over cropping, deforestation on eco system. 5.6 Explain the effects of some of the agricultural activities in 5.5 on soil nutrients 5.7 Explain irrigation-	● Explain degradation processes. ● Outline causes of land degradation. ● Discuss reclamation measures. ● Outline a case study of saline and sodic soil. ● Describe the effect of agricultural activities such as bush burning, overgrazing etc on soil nutrients.	Laptop Smart board, Projector, White board, Markers, Internet Pictures Videos Soil samples Multimedia Soil survey maps Etc.	● Identify degraded lands. ● Visit degraded irrigation plots. ● Observe areas with salt incrustation ● Observe areas affected by burning of grasses ● Observe bare soils and the cause.	Guide students on: ● Identify degraded lands. ● Visit degraded irrigation plots. ● Observe areas with salt incrustation ● Observe areas affected by burning of grasses ● Observe bare soils and the cause.	Soil kits Survey tools pH Conductivity meter, Soil testing kits, Litmus paper Camera GPS.

	induced degradation.					
General Objective 6.0: Understand land Management, conservation and reclamation using various methods						
14-15	6.1 Explain land reclamation concepts. 6.2 Explain Soil Salinity and Sodicty. 6.3 Describe the various methods of reclaiming saline and sodic soils. 6.4 Discuss the drainage as a reclamation measure. 6.4 Discuss integrated land management 6.5 Explain watershed management	• Demonstrate reclamation approaches • Describe saline and Sodic Soils. • Explain the various methods of reclaiming saline and sodic soils.	Charts Lecture materials Writing Materials, Whiteboard, Markers, Internet Pictures Videos Multimedia Soil survey map Etc.	• Practice drainage layout • Carry out conservation project presentation and field assessment • Evaluate conservation projects and field practical review.	Guide students on: • Practice drainage layout • Carry out conservation project presentation and field assessment • Evaluate conservation projects and field practical review	Drainage tools Practical plots pH meter Conductivity meter Soil samples Litmus paper.
COURSE ASSESSMENT: Coursework: 10% Test/Assignments: 10% Practical: 40% Examination: 40% Total: 100%						

LIST OF MINIMUM RESOURCES/PHYSICAL FACILITIES

1.0 IRRIGATION EQUIPMENT STORE

S/N	DISCRIPTION OF ITEMS	QUANTITY REQUIRED
Surface Irrigation		
1.	Surface irrigation demonstration model (basin, border, furrow)	3
2.	Furrow irrigation siphon tubes	10
3.	Border/basin land-levelling tools (scraper, grader blade)	1 set
4.	Irrigation canal cross-section models (demonstration)	2
5.	Irrigation scheduling boards / charts	10
Sprinkler Irrigation		
6.	Sprinkler irrigation training kit (complete)	5
7.	Rotating sprinkler heads — impact type	10
8.	Rotating sprinkler heads — gear-driven type	10
9.	Sprinkler heads (assorted)	30
10.	Sprinkler riser pipes and laterals	10 sets
11.	Catch cans (for uniformity testing)	50
Drip / Micro Irrigation		
12.	Drip irrigation training kit (complete)	5
13.	Drip irrigation demonstration set (complete)	5
14.	Drip emitters (various flow rates: 8,10,12 L/hr)	500
15.	Drip lateral tubing (16 mm)	300 m
16.	Drip main and sub-main pipes (50-75 mm)	150 m
17.	Pressure regulators	8
18.	Sand/screen filters and disc filters	5 each
19.	Fertigation injector (Venturi and pump type)	2
Centre-Pivot and Mechanised Irrigation		
20.	Mini centre-pivot irrigation model (demonstration)	1

a. Pipes, Fittings and Valves

S/N	EQUIPMENT	QUANTITY
1.	Pipe cutters and deburring tools	10
2.	Pipe wrenches (various sizes)	5
3.	Pipe threading machine	2
4.	Pipe repair kits (clamps, couplings, patch kits)	5 sets
5.	Pipe leak detection equipment (acoustic or visual)	12 set
6.	Control/irrigation valves (assorted)	20
7.	Solenoid valves (24V AC)	20
8.	Check valves / non-return valves	10
9.	Air release valves	10
10.	Pressure gauges (0–6 bar)	10
11.	Teflon tape and solvent cement/primer for PVC	10 sets
Pipe Tools		
12.	Pipe cutters and deburring tools	10
13.	Pipe wrenches (various sizes)	5
14.	Pipe threading machine	2
15.	Pipe repair kits (clamps, couplings, patch kits)	5 sets
16.	Pipe leak detection equipment (acoustic or visual)	12 set

b. Pumps and Power

S/N	DISCRIPTION OF ITEMS	QUANTITY REQUIRED
1.	Submersible pump (0.5–3 HP)	5
2.	Surface centrifugal pump (1–3 HP)	3
3.	Electric motor pump	3
4.	Portable generator (backup power)	3
5.	Pump maintenance tools (bearing pullers, seal kits)	2 sets
6.	Spare pumps (for maintenance practicals)	2
Water Storage and Distribution		
7.	Portable water storage tank (1,000 L)	3
8.	Water supply source (borehole or header tank)	3
9.	Irrigation equipment store / tool shed	1

Flow Measurement		
10.	Parshall flume (portable demonstration model)	1
11.	Cut-throat flume (portable)	1
12.	V-notch and rectangular weir boards	2 sets
13.	Flow meter / electromagnetic or ultrasonic	10
14.	Flow sensor (digital, in-line)	20
15.	Water level sensor	20
16.	Water level staff gauges	4
17	Water meter (volumetric)	5
19	Current meter	2
20	Venturi meter apparatus	1
21	Orifice meter apparatus	1
22	Measuring tank (flow calibration)	2
23	Water measuring cylinders (field use)	4

System Testing, Commissioning and Automation Laboratory

S/N	DISCRIPTION OF ITEMS	QUANTITY REQUIRED
1.	Pressure test pump	2
2.	Multi-meter (electrical testing)	10
3.	Solenoid valve testing and maintenance kit	1 set
4.	Irrigation controllers / programmable timers	5
5.	Smart irrigation demonstration kit (integrated IoT)	5
6.	Laser distance meter	5

2.0 soil and water measurement Laboratory

Soil Sampling and Physical Analysis

S/N	EQUIPMENT	QUANTITY
1.	Soil augers (hand operated, various diameters)	10
2.	Installation auger	5
3.	Core samplers (for bulk density determination)	10
4.	Soil moisture sample tins / aluminium cans	50
5.	Desiccator	2
6.	Analytical balance (0.01 g accuracy)	2
7.	Oven (105°C, laboratory grade)	2
8.	Soil texture analysis kit (hydrometer and sieve method)	5 sets
9.	Double-ring infiltrometer	5
10.	Pocket penetrometer / soil compaction tester	3
11.	Soil hardness tester	2
12.	Soil permeability meter (Guelph permeameter)	1
13.	Pressure membrane apparatus (pressure plate extractor)	1
14.	Lysimeter	2
15.	Measuring tape (field use)	10

c. Soil Chemical Analysis

S/N	EQUIPMENT	QUANTITY
1.	Soil pH meter (portable)	5
2.	Electrical conductivity (EC) meter, portable	5
3.	Soil pH and NPK test kit (field)	3
4.	Water analysis kit	3
5.	Irrigation water testing set	3
6.	Irrigation water tester	2
Soil Moisture Measurement		
7.	Tensiometers (with vacuum gauge)	15
8.	Capacitance / FDR soil moisture sensors	30

9	TDR probe (time-domain reflectometry)	2
10	Watermark gypsum block sensors	10
11	Watermark gypsum block reader / meter for gypsum blocks	2
12	Neutron moisture meter (demonstration type)	1
13	Speedy moisture tester	2
14	Soil moisture meter (handheld)	15
15	Look-and-feel reference chart (laminated)	10
16	Infrared thermometer (canopy temperature)	3
Water Quality		
1.	Portable EC and pH water meter (combo)	3
2.	Turbidity meter	2
3.	Water sampling bottles	20
Groundwater and Drainage		
4.	Water table monitoring tubes (piezometers)	4
5.	Perforated drainage pipes (PVC, 100 mm)	20 m
6.	Geotextile filter fabric	10 m ²
7.	Drainage design software (WinDRAIN or equivalent)	1 licence

3.0 METEOROLOGICAL Station

S/N	EQUIPMENT	QUANTITY
1.	Automatic weather station (AWS) — complete unit	1
2.	Stevenson's screen	1
3.	Thermo-hydrograph	1
Temperature and Humidity		
4.	Maximum–minimum thermometers	5
5.	Thermometer (field / standard)	5
6.	Hygrometer	5
7.	Psychrometer	2
8.	Digital temperature–humidity logger (DHT22 or equivalent)	10

d. Rainfall

S/N	EQUIPMENT	QUANTITY
1.	Rain gauge — manual (standard cylinder type)	5
2.	Rain gauge — tipping bucket (automatic)	2
3.	Measuring glasses for rain gauge reading	4
Wind		
4.	Anemometer (cup type)	2
5.	Wind vane	2
6.	Windage counter	1
Radiation and Pressure		
7.	Pyranometer / solar radiation meter	2
8.	Barometer	2
Evaporation		
9.	Class A evaporation pan (with anemometer and gauge)	1
10.	Evaporimeter	2
11.	Evaporation gauge	2
4.0 SURVEYING EQUIPMENT		
Field Instruments		
12.	Automatic dumpy level	3
13.	Levelling staff (4 m, telescopic)	5
14.	Theodolite (analogue or digital)	3
15.	Total station (electronic)	2
16.	Prismatic compass	5
17.	Gunter compass	5
18.	GPS receiver (handheld)	10
19.	Stadia rod	2
Linear Measurement		
20.	Surveying tape (30 m steel)	5
21.	Surveying tape (50 m fibreglass)	5
22.	Ranging poles	10

23.	Pegs and a sledgehammer	20 pegs, 2 hammers
24.	Chains	3
25.	Quadrants/sextants	2
26.	Interrow weeder	1
27.	Manure spreader	

e. Drawing Studio

S/N	EQUIPMENT	QUANTITY
1.	Drawing boards (A1 size)	10
2.	Drawing sets (compasses, dividers, set squares, protractors)	20 sets
3.	Drawing paper (A1 size)	2 reams
4.	Drawing tables	10
5.	Rulers, pencils, erasers, ink pens	30 sets
6.	Survey field books	30
7.	Plotter printer (A0/A1)	1
8.	CAD software (AutoCAD / EPANET or free equivalent)	10 licences

f. DIGITAL AGRICULTURE and SMART IRRIGATION LABORATORY

Microcontrollers and Sensors		
1.	SEZP32 microcontroller boards	20
2.	Arduino development boards	20
3.	Raspberry Pi boards	5
4.	Capacitance / FDR soil moisture sensors (multi-type)	30
5.	Temperature and humidity sensors (DHT22 or equivalent)	20
6.	Rain sensors (tipping bucket, wireless)	4
7.	Crop canopy temperature sensors	4
8.	EC soil sensors (apparent electrical conductivity)	2
9.	Water level sensors	20
10.	Flow sensors (digital, inline)	20
11.	Relay modules (4-channel)	10
12.	Solenoid valves (12V and 24V)	20 each
Connectivity and Communication		

13.	Wi-Fi router / IoT gateway	2
14.	GSM / Wi-Fi communication modules	10 each
15.	LoRa communication modules	5
16.	SIM cards (data-enabled)	10
17.	Jumper wires, breadboards, USB cables	20 sets
Dataloggers and Monitoring		
18.	Datalogger (multi-channel, with SD card)	10
19.	IoT platform access — Things Board / Blynk (cloud accounts)	10 accounts
20.	Smartphones for remote app control	10
21.	External data storage server	1

g. GIS, Remote Sensing and Aerial Laboratory

S/N	EQUIPMENT	QUANTITY
1.	Computers with QGIS installed (free GIS software)	20
2.	GIS software licence (ArcGIS or QGIS)	20
3.	GPS receivers for georeferencing and field mapping	10
4.	Sentinel-2 / Landsat satellite imagery (downloaded datasets)	1 set
5.	SMAP satellite soil moisture data (downloaded)	1 set
6	Remote sensing image database	1
7	Internet access for satellite data portals	20 connections
8	Drone (training/mapping type)	1
9	Digital camera	5
Software		
6.	FAO CROPWAT (crop water requirement software)	1
7.	QGIS (GIS software)	20
8.	EPANET (hydraulic design software)	10
9.	WinDRAIN or equivalent (drainage design)	1
10.	Irrigation design and simulation software	20
11.	Climate modelling software	10
12.	Spreadsheet software (Excel or LibreOffice)	20
13.	Financial analysis software	20

Wood workshop

Hand Tools		
14.	Bench vices (workshop-grade)	5
15.	Hammers (ball peen and claw)	10
16.	Chisels (flat and cross-cut)	10
17.	Files (flat, round, half-round)	10 sets
18.	Screwdrivers (flat and Phillips, various sizes)	10 sets
19.	Spanners/wrenches (open-end and ring, metric set)	5 sets
20.	Hacksaw frames and blades	10
21.	Centre punch and scribes	10 sets
22.	Steel rule, try square, marking gauge	5 sets
23.	Hand tool kit (general field maintenance set)	15
24.	Tool box set (portable field kit)	10
Power Tools		
25.	Electric hand drill with bit set	3
26.	Portable angle grinder	2
27.	Bench grinder	1
28.	Welding machine	2
29.	Pipe threading machine	2

Hydraulics Demonstration		
30.	Hydraulic bench (demonstration unit)	1
31.	Bernoulli demonstration apparatus	1
32.	Pitot tube assembly	1
33.	Orifice and mouthpiece apparatus	1
34.	U-tube manometers	5
35.	Pipe friction loss apparatus	1
36.	Centrifugal pump (demonstration model)	2
37.	Flow measurement demonstration kit	1
Workspaces		
38.	Workbenches (heavy-duty)	5
39.	Tool storage cabinet / rack	2

h. GREENHOUSE and CROP PRODUCTION EQUIPMENT

S/N	EQUIPMENT	QUANTITY
1.	Greenhouse structure 8 by 24m	1 Core facility
2.	Benches / potting tables	10
3.	Plastic pots (various sizes)	50
4.	Plastic cups (seedling raising)	20
5.	Hand forks, hand trowels and hand hoes	10 each
Crop Monitoring and Measurement		
6.	Leaf area meter (portable)	1
7.	SPAD chlorophyll meter	2
8.	Plant water potential kit (pressure bomb)	1
9.	Microscope (for root and pest examination)	2
10.	Crop growth monitoring tools (rulers, callipers, crop loggers)	10 sets
11.	Digital weighing balance	5 Crop yield measurements
Fertigation and Watering		
12.	Fertigation demonstration kit	5 Nutrient application through irrigation
13.	Watering equipment set (watering cans, hoses)	10
Harvest and post-harvest		

14.	Weighing scale (field, 50 kg capacity)	3
15.	Harvest bags/crates	20
16.	Grading and packaging materials	1 set
Soil Conservation (Demonstration)		
17.	Soil erosion measurement pins/erosion bridges	10
18.	Runoff measurement trough and measuring cylinder	2 sets
19.	Contour planning A-frame level	5
20.	Mulching materials (straw and plastic mulch)	1 set
Field Demonstration Farm		
21.	Demonstration irrigation farm (minimum 1 ha)	1 Core facility
22.	Drought simulation/deficit irrigation plot	1 Climate adaptation studies
23.	Water harvesting demonstration unit	2 Water conservation practical
24.	Trenching and land-preparation tools (picks, spades, shovels)	10 sets
25.	Hand tool set (hoe, cutlass, rake)	10
26.	Field vehicles (for site visits and supervision)	1

h. Computing and Audio-Visual studio

S/N	EQUIPMENT	QUANTITY
1.	Desktop/laboratory computers (internet-enabled)	20
2.	Laptop computers	10
3.	Tablets (for field data collection)	10
4.	LCD / multimedia projector and screen	2
5.	Interactive smart board	1
6.	Whiteboard and markers	4
7.	Public address system	1
8.	Audio recorder	5
9.	Video conferencing system	1
10.	Audio-visual recording equipment (camera / smartphone)	5
11.	Printer/scanner (A3/A4)	2
12.	Plotter printer (A0/A1)	1
13.	Internet facility (broadband connection)	1
14.	External storage server	1

15.	Digital library access system	1
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i. Other facilities

S/N	EQUIPMENT	QUANTITY
1.	Seminar hall	1 Minimum 50-seat capacity
2.	Conference table set	1 Policy simulation and stakeholder meetings
3.	Scientific calculators	1 per student
Safety and Personal Protective Equipment		
4.	Laboratory overalls / coveralls	One per student
5.	Safety goggles	One per student
6.	Chemical-resistant gloves	1 pair per student
7.	Rubber boots / safety boots (gumboots)	1 pair per student
8.	Face masks / dust masks	Lots
9.	Safety helmets	One per student (Field safety compliance)
10.	Reflective safety vests	One per student
11.	First aid kit	2
12.	Safety signage for laboratory and field	1 set
SIWES and Field Documentation		
13.	SIWES logbooks	One per student
14.	Field measurement toolkit (tapes, rods, notebooks)	One per student
15.	Transportation support vehicle	1
16.	Data recording sheets and field books	Lots
17.	Report templates and marking rubrics	1 set per course
18.	Recommended textbooks and e-books (library copies)	Lots

LIST OF PARTICIPANTS DURING THE NATIONAL CURRICULUM REVIEW WORKSHOP

S/N	NAME	ADDRESS	EMAIL
1.	Prof. Idris M. Bugaje	Executive Secretary, NBTE Kaduna	es@nbte.gov.ng
2.	Dr. Usman D. Idris	Sanaya Engineering and Consulting Ltd, Zaria	udidris11@gmail.com
3.	Engr. Dr. Dahiru Muhammed	Federal College of Agriculture and Technology, Nabangi, Katsina State	wadata4all@gmail.com
4.	Engr. Abubakar Ahmed	Bauchi State College of Agriculture, Bauchi	a
5.	Engr. Alhassan Yahaya	Nuhu Bamalli Polytechnic Zaria	alhassanyahaya47@gmail.com
6.	Engr. Hatim Miftah Garba	Bin Miftah International Enterprise, Kano	hatimgarba@gmail.com
7.	Arc. Kabir Ibrahim	NABG Nigeria Agric Business Group, Abuja.	kebrangroup@gmail.com
8.	Engr. Dr. Ogundana Odunayo Seyi	Federal College of Fresh Water and Fisheries Technology, New Bussa	odnmansam@gmail.com
9.	Engr. Dr. O.O Bello	Director, Curriculum Development, National Board for Technical Education, Kaduna	engroobello@gmail.com
10.	Mr. Ayo Aroge	Director, Polytechnic and Allied Programmes, National Board for Technical Education, Kaduna	ayoaroge2@gmail.com
11.	Dr. Kubra Jauro Danlawan	Deputy Director, Agric Technology Division , National Board for Technical Education, Kaduna	kuburagombe@yahoo.com
12.	Muhammad Aliyu Maiwada	National Board for Technical Education, Kaduna	maiwada1990@gmail.com
13.	Ruqayya Uthman	National Board for Technical Education, Kaduna	ruqayyauthman87@gmail.com
14.	Usman Sabo	National Board for Technical Education, Kaduna	usmansabo42@gmail.com
15.	Haulatu Idris Adamu	National Board for Technical Education, Kaduna	haulat5773@gmail.com