Government of the Netherlands

FEDERAL GOVERNMENT OF NIGERIA

NATIONAL BOARD FOR TECHNICAL EDUCATION

NATIONAL DIPLOMA (ND)

RENEWABLE ENERGY TECHNOLOGY

CURRICULUM AND COURSE SPECIFICATIONS

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

APRIL, 2025

INCLUDE
KNOWLEDGE PLATFORM ON INCLUSIVE DEVELOPMENT POLICIES

FOREWORD

The National Diploma (ND) in Renewable Energy Technology curriculum has been developed to provide a foundational skills in the field of renewable energy, preparing technicians to contribute effectively to this growing industry in Nigeria.

This curriculum is designed to introduce students to the core principles, technologies, and applications of various renewable energy sources, laying a solid groundwork for further specialization and career development. It aims to equip graduates with the essential knowledge and skills to support the installation, operation, and basic maintenance of renewable energy systems.

I would like to express my sincere appreciation to the African Studies Center, Leiden (ASCL), Netherlands, under their INCLUDE KNOWLEDGE PLATFORM, for sponsorship and valuable contribution to the review of this curriculum. Their support underscores the importance of building local capacity in the renewable energy sector.

It is my hope that the effective implementation of this National Diploma program will create a pipeline of skilled technicians who will be instrumental in the deployment and utilization of renewable energy technologies across Nigeria, contributing to a cleaner environment and a more sustainable energy future.

Prof. Idris M. Bugaje
EXECUTIVE SECRETARY
NBTE, KADUNA

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GENERAL INFORMATION

1.0 TITLE OF THE PROGRAMME

The programme is National Diploma (ND) Renewable Energy Technology

2.0 GOAL AND OBJECTIVES OF THE PROGRAMME

2.1 GOAL: The National Diploma (ND) in Renewable Energy Technology is aimed at producing technicians with the requisite knowledge and skills to install, repair and maintain basic renewable energy technology systems.

At the end of the programme the technician should be able to:

1. Apply the principles of physics and chemistry in Renewable Energy
2. Support to install and maintain Renewable Energy system
3. Apply appropriate technology for Renewable Energy System
4. Support in carrying out research on Renewable Energy System
5. Apply appropriate software packages in Renewable Energy System
6. Support in carrying out engineering project management
7. Apply engineering professional ethics
8. Identify effects of Renewable Energy on the environment
9. Setup and manage small business

3.0 ENTRY REQUIREMENTS

The entry requirements for National Diploma in Renewable Energy Engineering Technology are:

a. A minimum score in the Unified Tertiary Matriculation Examination (UTME) as stipulated by JAMB

b. Possesses either of the following:

i. Five (5) Credit O-level passes at West African Senior School Certificate Examination (WASSCE), Senior School Certificate Examination (SSCE) or their equivalents at not more than TWO sittings. The five (5) subjects must include English Language, Mathematics, Physics, Chemistry, and any other relevant subject.

ii. The National Technical Certificate (NTC) with five credit passes in not more than TWO sittings. The five (5) subjects must include English Language, Mathematics, Physics, Chemistry, and any other relevant subject

4.0 DURATION

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

5.0 CURRICULUM

1. The curriculum of all ND programmes consists of four main components. These are:

   5.1 General studies/Education
   5.2 Foundation courses
   5.3 Professional courses

   5.4 Supervised Industrial Work Experience Scheme(SIWES)

2. The General Studies/Education component shall include courses in:
   i. *Art and Humanities*-English language, Communication. These are compulsory
   ii. Mathematics and Science

iii. *Social Studies* - Citizenship, political science, sociology, philosophy, geography, entrepreneurship studies. The courses in citizenship, entrepreneurship are compulsory.

3. The General Studies/Education component shall account for not more than 15% of the total contact hours for the programme.
4. Foundation courses include courses in Mathematics, Statistics. The number of hours will vary with the programme and may account for about10-15% of the total contact hours depending on the programme.
5. Professional courses are courses which give the student the theory and practical skills he/she needs to practice in his/her field of specialization at the technician level. These may account for between 60-70% of the contact hours depending on the programme.
6. Supervised Industrial Work Experience (SIWES) shall be taken during the long vacation following the end of the second semester of the first year. See details of SIWES at Paragraph 10.0.

6.0 CURRICULUM STRUCTURE

The structure of the ND programme consists of four (4) semesters of class room, laboratory, field, and workshop activities in the College and SIWES. Each semester shall be of seventeen(17) weeks duration made up as follows.

1. Fifteen (15) contact weeks of teaching,i.e lecture, test, quizzes, recitation, practical exercise, etc.
2. Two (2) weeks for the conduct of examinations. The SIWES registration shall take place at the end of the second semester of the first year for the ND programme.

7.0 ACCREDITATION

The programme offered at the ND level shall be accredited by the NBTE before the diplomates can be awarded ND Certificate. Details about the process of accreditation for the award of the ND programme is available from the Executive Secretary, National Board for Technical Education, Plot B,BidaRoad,P.M.B2239,Kaduna,Nigeria.

8.0 CONDITIONS FOR THE AWARD OF THE NATIONAL DIPLOMA

Institutions offering accredited programmes will award the National Diploma to candidates who successfully completed the programme after passing prescribed coursework, examination, diploma project and the supervised industrial work experience. Such candidates should have completed a minimum of 91 and maximum of 105 credit units.

8.1 Grading of Courses:

Courses shall be graded as follows:

Mark Range	Letter Grade	Weighting
75% and above	A	4.00
70% - 74%	AB	3.50
65% - 69%	B	3.25
60% - 64%	BC	3.00
55% - 59%	C	2.75
50% - 54%	CD	2.50
45% - 49%	D	2.25
40% - 44%	E	2.00
Below 40%	F	0.00

8.2 Classification of Diplomas: National Diplomas shall be classified as follows:

Distinction - CGPA of 3.50 -4.00
Upper Credit - CGPA of 3.00 - 3.49
Lower Credit - CGPA of 2.50 - 2.99
Pass - CGPA of 2.00-2.49

9.0 QUALIFICATION OF THE TEACHERS

9.1 Holders of BSc / HND and Higher Degrees in:

i. Renewable Energy Engineering,
ii. Chemical Engineering,
iii. Electrical/ Electronic Engineering,
iv. Computer Engineering,

9.2 In addition, teachers of this programme should have been trained and certified by:
(a) Council for the Regulation of Engineering in Nigeria (COREN)
(b) Industrial certifications in Engineering

9.3 Headship of the Department:
Holders of HND or Bachelor's degree in any of the Engineering fields listed in 9.1
Higher Degree: Renewable Energy Engineering and Energy Engineering, who must not be below the rank of a Senior Lecturer

10.0 GUIDANCE NOTES FOR TEACHERS OF THE PROGRAMME

10.1 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 that will enable a student who wish to transfer the units already completed in an institution of similar standards from which he is transferring.

10.2 In designing the units, the principle of the modular system by the product has been adopted; thus making each of the professional modules, when completed provides the students with technician operative skills, which can be used for the employment purposes. Also, he can move ahead for post ND studies.

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

10.4 The teaching of the theory and practical work should, as much as possible, be integrated. Practical exercises, especially those in professional course and laboratory work should be taught in isolation from the theory. For each course, there should be a balance of theory-practical in the ratio of 50:50 or 60:40 or the reverse.

11.0 GUIDELINES ON SIWES PROGRAMME

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

i. RESPONSIBILITY FOR PLACEMENT OF STUDENTS

Institution offering the ND programme shall arrange to place the students in the industry. Latest by April 30 of each year; six copies of the master list showing where each student has been placed shall be submitted to the Executive Secretary, NBTE which shall, in turn authenticate the list and forward it to the Industrial Training Fund (ITF), Jos.

ii. The Placement Officer should discuss and agree with industry on the following:

a) A task inventory of what the students should be expected to experience during the period of attachment. It may be wise to adopt the one already (ND) approved for each field.
b) The industry-based supervisor of the students during the period likewise the institution-based supervisor. The evaluation of the students during the period. It should be noted that the final grading of the student during the period of attachment should be weighted on the evaluation by his industry-based supervisor.

11.2 EVALUATION OF STUDENTS DURING SIWES

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

i. Punctuality

ii. Attendance

iii. General Attitude to work

iv. Respect for authority

v. Interest in the field/technical area

vi. Technical competence as a potential technician in his field.

11.3 GRADING OF SIWES

To ensure uniformity of grading scale, the institution should ensure that uniform grading of student's work which has been agreed to by all polytechnics is adopted.

11.4 THE INSTITUTION BASED SUPERVISOR

The institution-based supervisor should endorse the logbook 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 problem regarding the specific assignments given to them by their industry-based supervisor.

11.5 FREQUENCY OF VISIT

Institutions should ensure that students placed on attachment are visited within one month of their placement.

Other visits shall be arranged so that:

i. There is another visit six (6) weeks after the first visit; and
ii. A final visit in the last month of the attachment.

11.6 STIPEND FOR STUDENTS ON 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.

11.7 SIWES AS A COMPONENT OF THE CURRICULUM

The completion of SIWES is important in the final determination of whether the student is successful in the programme or not. Failure in the SIWES is an indication that the student has not shown sufficient interest in the field or has no potential to become a skilled technician in his field. The SIWES should be graded also on credit unit system. Where a student has satisfied all other requirements but

failed SIWES, he may only be allowed to repeat another four (4) months SIWES at his own expense.

11.8 LOGBOOK

The candidates are expected to record and up-keep a personal logbook. This will contain daily and weekly summary of curricular activities carried out by the candidates for each semester. The ND programme coordinator of the department will supervise the assessment and evaluation of the logbook.

12.0 FINAL YEAR PROJECT

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

13.0 MANDATORY SKILLS QUALIFICATIONS (MSQ)

See Guidelines for the Implementation of MSQ in Polytechnics in Nigeria

CURRICULUM TABLE

YEAR I SEMESTER I

S/N	Course Code	Course Title	L	P	CU	CH
1	GNS 101	Use of English I	2	0	2	2
2	GNS 111	Citizenship Education I	2	0	2	2
3	MTH 112	Algebra and Elementary Trigonometry	2	0	2	2
4	COM 111	Introduction to Computing	2	2	3	4
5	MEC 111	Technical Drawing I	1	3	3	4
6	MEC 113	Basic Workshop Technology & Practice	1	3	3	4
7	EEC 114	Electrical Engineering Science I	1	2	3	3
8	MSQ	Mandatory Skills Qualification	0	0	0	2
9	RET 111	Introduction to Renewable Energy	1	2	3	3
10	RET 112	Physics of RE Systems	1	1	2	2
11	RET 113	Chemistry for RE Systems	1	1	2	2
12	**TOTAL**		**14**	**14**	**25**	**30**

YEAR I SEMESTER II

S/N	Course Code	Course Title	L	P	CU	CH
1	GNS 102	Communication in English I	2	0	2	2
2	GNS 121	Citizenship Education II	2	0	2	2
3	ENT 126	Introduction to Entrepreneurship I	2	1	3	3
4	MTH 211	Calculus	2	0	2	2
5	MEC 122	Thermodynamics I	2	2	3	4
6	MEC 121	Engineering Graphics	1	2	2	3
7	EEC 123	Electronics I	1	2	2	3
8	EEC 124	Electrical Engineering Science II	1	2	3	3
9	EEC 125	Use of Instruments	1	3	2	4
10	RET 121	Renewable Energy and Environment	1	2	3	3
11	RET 122	Introduction to Digital Electronics	2	1	3	3
12	MSQ	Mandatory Skills Qualification	0	0	0	2
13	**TOTAL**		**17**	**15**	**27**	**34**

YEAR II SEMESTER I

S/N	Course Code	Course Title	L	P	CU	CH
1	GNS 202	Communication in English II	2	0	2	2
2	ENT 216	Introduction to Entrepreneurship II	2	1	3	3
3	MTH 122	Trigonometry and Analytical Geometry	1	0	2	2
4	MEC 214	Fluid Mechanics	2	2	3	4
5	RET 211	Renewable Energy Installation and Maintenance I	1	2	3	3
6	RET 212	Renewable Energy Technology & Application I	1	2	3	3
7	RET 213	Research Methodology in RE	1	1	2	2
8	RET 214	Introduction to RE application packages	1	1	2	2
9		SIWES	0	0	3	3
10	**TOTAL**		**11**	**9**	**23**	**24**

YEAR II SEMESTER II

S/N	Course Code	Course Title	L	P	CU	CH
1	RET 221	Renewable Energy Installation and Maintenance II	1	2	3	3
2	RET 222	Renewable Energy Technology & Application II	1	2	3	3
3	RET 223	Emerging Technologies in RE	2	0	2	2
4	RET 224	Engineering Project Management	1	1	2	2
5	RET 225	Engineering Ethics	2	0	2	2
6	RET 226	Project	0	0	4	4
	TOTAL		**7**	**5**	**16**	**16**

Introduction to Renewable Energy

PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY		
COURSE TITLE: **Introduction to Renewable Energy**	Course Code: RET 111	Contact Hours: 3
	Credit Unit: 3	Theoretical: 1
Year: I Semester: I	Pre-requisite: Nil	Practical: 2 Hour/week
GOAL: This course is designed to acquaint students with the knowledge and skills of Renewable Energy		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the basic concept of renewable energy 2.0 Know renewable energy sources 3.0 Know the concept and applications of solar energy 4.0 Know the concept and applications of wind energy 5.0 Know the concept and applications of hydropower systems 6.0 Know the concept and application of biomass energy 7.0 Understand the concept and application of geothermal energy 8.0 Understand the concept of energy storage system		

PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY						
COURSE TITLE: **Introduction to Renewable Energy**		Course Code: RET 111		Contact Hours: 3		
		Credit Unit: 3		Theoretical: 1		
Year: I Semester: I		Pre-requisite:		Practical: 2 Hour/week		
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to acquaint the students with the knowledge and skills of Renewable Energy						
GENERAL OBJECTIVE 1.0: Understand **the basic concept of Renewable Energy**						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1	1.1 Define energy 1.2 Explain the types of Renewable Energy sources 1.3 Explain the classification of energy into renewable and non-renewable 1.4 Explain the advantages and disadvantages of renewable energy 1.5 Explain the advantages and disadvantages of non-renewable energy	Explain energy Describe the types of energy sources Explain the classification of energy into renewable and non-renewable Explain the advantages and disadvantages of renewable energy Explain the advantages and disadvantages of non-renewable energy	Textbooks Lecture notes journals Projector PC Marker Board Marker Internet			
General Objective 2.0: **Know Renewable Energy sources**						
2-3	2.1 Define Renewable Energy	Explain Define Renewable Energy	Textbooks Lecture notes	Identify simple renewable energy	Guide students to: Identify simple	Solar panels Portable

	2.2 Describe Renewable Energy sources ▪ Solar thermal ▪ Solar PV ▪ Wind ▪ Hydro ▪ Biomass ▪ Tidal ▪ Geothermal ▪ Hydrogen fuel 2.3 Outline the applications of Renewable Energy sources.	Discuss Renewable Energy sources ▪ Solar thermal ▪ Solar PV ▪ Wind ▪ Hydro ▪ Biomass ▪ Tidal ▪ Geothermal ▪ Hydrogen fuel Explain the applications of Renewable Energy sources.	journals Projector PC Marker Board Marker Internet	devices/systems: • Solar panels • Portable windmills • Hydropower • Biomass	renewable energy devices/systems: • Solar panels • Portable windmills • Hydropower Biomass	windmills Hydropower chart Biomass chart
General Objective 3.0: **Know the concept and applications of Solar Energy**						
4-5	3.1 Define Solar Energy 3.2 Explain geometry of the Earth and Sun 3.3 Explain extraterrestrial solar radiation 3.4 Outline the components of solar radiation 3.5 Explain the methods of measuring solar radiation	Explain Solar Energy Explain geometry of the Earth and Sun Explain extraterrestrial solar radiation Outline the components of solar radiation Explain the methods of measuring solar radiation Explain the principles of	Textbooks Lecture notes journals Projector PC Marker Board Marker Internet	Identify: • Solar dryer • Solar cooker • Solar water heater • Solar distiller • Solar thermal power system Measure solar radiation levels at different time of the day	Guide the students to: Identify: • Solar dryer • Solar cooker • Solar water heater • Solar distiller • Solar thermal power system • Solar PV System	Pyranometer Video Clip Charts

	3.6 Explain the principles of operation of the following: ▪ Solar PV power system ▪ Solar cooker ▪ Solar water heater ▪ Solar distiller ▪ Solar thermal power system 3.7 Outline advantages and disadvantages of solar energy	operation of the following: ▪ Solar PV power system ▪ Solar cooker ▪ Solar water heater ▪ Solar distiller ▪ Solar thermal power system Explain advantages and disadvantages of solar energy			Measure solar radiation levels at different time of the day	
General Objective 4.0: **Know the concept and applications of wind energy**						
6-7	4.1 Explain wind energy potentials 4.2 Explain the different types of wind energy systems: • wind Turbines, • Windmills, • Wind powered Water pump, etc 4.3 Explain the components of wind energy conversion system: • Rotor blades, • Hub, • Shaft,	Explain wind energy potentials Explain the different types of wind energy systems: • wind Turbines, • Windmills, • Wind powered Water pump, etc Explain the components of wind energy conversion system: • Rotor blades, • Hub,	Textbooks Lecture notes journals Projector PC Marker Board Marker Internet	Identify various types/parts of wind turbine. Measure wind speed. Measure wind direction.	Guide the students to: Identify various types/parts of wind turbine. Measure wind speed. Measure wind direction.	Prototype of wind turbine system (Fabricated) Anemometer wind vane.

	• Gearbox, • Generator, etc. 4.4 Explain the applications of Wind Energy systems in the following • Electricity generation, • Water Pumping • Battery Charging, • Hydrogen production, etc. 4.5 Explain wind turbines 4.6 Explain the operating principle of wind turbine 4.7. Explain the applications of Wind Turbine in the following: • Electricity generation, • Water Pumping • Battery Charging, • Hydrogen production, etc 4.8 Explain the process of wind turbine power extraction	• Shaft, • Gearbox, • Generator, etc Explain the applications of Wind Energy systems in the following • Electricity generation, • Water Pumping • Battery Charging, • Hydrogen production, etc. Explain wind turbines Explain the operating principle of wind turbine Explain the applications of Wind Turbine in the following: • Electricity generation, • Water Pumping • Battery Charging, • Hydrogen production, etc Explain the process of wind turbine power				

		extraction				
General Objective 5.0: Understand the concept and applications of hydropower systems						
8-9	5.1 Define hydropower 5.2 Explain hydropower energy potentials 5.3 Explain the different types of hydropower energy systems: • Impoundment hydropower (Dam-based) • Run-of River hydropower, • Pumped Storage Hydropower, etc. 5.4 Explain principle of operation of hydropower systems 5.5 Explain the components of a hydropower conversion system: • Intake structure, • Penstock, • Turbine, • shaft, • generator,	Explain hydropower Explain hydropower energy potentials Explain the different types of hydropower energy systems: • Impoundment hydropower (Dam-based) • Run-of River hydropower, • Pumped Storage Hydropower, etc. Explain principle of operation of hydropower systems Explain the components of a hydropower conversion system: • Intake structure, • Penstock, • Turbine,	Textbooks Lecture notes journals Projector PC Marker Board Marker Internet	Identify various components of small hydro power systems.	Guide students to: Identify various components of small hydro power systems: • Pressure gauge, • Alitimeter,	Prototype of small hydro power (Fabricated) Pressure gauge, Alitimeter,

	• control system etc 5.6 Expain the process of hydro turbine power extraction 5.7 Outline areas of application of hydropower system. 5.8 Outline social and environmental aspects of hydro power systems	• shaft, • generator, • control system etc Explain the process of hydro turbine power extraction Outline areas of application of hydropower system. Outline social and environmental aspects of hydro power systems				
General Objective 6.0: **Know the concept and application of Biomass Energy**						
10-11	6.1 Define Biomass 6.2 Explain Biomass energy potentials 6.3 List the types of Biomass 6.4 Explain the Fuel content of various types of Biomass 6.5 Explain the method of extracting energy from biomass: ▪ Direct combustion,	Define Biomass Explain Biomass energy potentials List the types of Biomass Explain the Fuel content of various types of Biomass Explain the method of extracting energy from biomass: ▪ Direct combustion,	Textbooks Lecture notes journals Projector PC Marker Board Marker Internet	Identify the various types of biomass: • Jatropha carcass • Sugarcane • Maize, • Animal dung, • Human faeces, etc. Identify Biomass System components: • Digesters • Cylinders • Bunners	Guide students to: Identify the various types of biomass: • Jatropha carcass • Sugarcane • Maize, • Animal dung, • Human faeces, etc. Identify Biomass System	Prototype of Biomass system (fabricated)

	▪ Gasification, ▪ Pyrolysis and ▪ Anaerobic digestion 6.6 Explain the principles and mechanism of bioconversion of waste to energy 6.7 Explain the principles of biofuel production. 6.8 State areas of application of biomass energy resources 6.9 State the advantages and disadvantages of biofuel production	▪ Gasification, ▪ Pyrolysis and ▪ Anaerobic digestion Explain the principles and mechanism of bioconversion of waste to energy Explain the principles of biofuel production. Explain areas of application of biomass energy resources Explain the advantages and disadvantages of biofuel production		• Soxhlet extractors • Biodigesters	components: • Digesters • Cylinders • Bunners • Soxhlet extractors • Biodigesters	
General Objective 7.0: Understand the concept and application of Geothermal Energy						
12-13	7.1 Define geothermal energy 7.2 Explain geothermal energy potentials 7.3 Explain types of geothermal energy systems	Explain geothermal energy Explain geothermal energy potentials Explain types of geothermal energy systems	Textbooks Lecture notes journals Projector PC Marker Board Marker Internet			

	7.4 Explain principle of operation of geothermal plants 7.5 Explain the mode of extraction and distribution of geothermal energy	Explain principle of operation of geothermal plants Explain the mode of extraction and distribution of geothermal energy				
General Objective 8.0: Understand the concept of energy storage systems						
14-15	8.1 Explain the concept of energy storage 8.2 Explain importance of energy storage 8.3 Explain the following energy storage systems: • Biological • Chemical • Electrical • Electrochemical • Mechanical • Thermal 8.4 Explain batteries and accumulators 7.6 Explain fuel cells	Explain the concept of energy storage Explain importance of energy storage Explain the following energy storage systems: • Biological • Chemical • Electrical • Electrochemical • Mechanical • Thermal Explain batteries and accumulators	Textbooks Lecture notes journals Projector PC Marker Board Marker Internet	Identify various energy storage systems	Guide the students to demonstrate energy storage.	Rechargeable batteries Multimeter

		Explain fuel cells				
	ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 60% of the total score. The end of the Semester Examination will make up for the remaining 40% of the total score.					

Physics of Renewable Energy Systems

PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY		
COURSE TITLE: Physics of Renewable Energy Systems	Course Code: RET 112	Contact Hours:
	Credit Unit: 2	Theoretical: 1
Year: I Semester: I	Pre-requisite:	Practical: 1 Hour/week
GOAL: This course is designed to acquaint students with the knowledge and skills of Physics application in Renewable Energy		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the concept of Energy 2.0 Understand Thermodynamics and Energy 3.0 Understand Physics of Solar and Wind Energy Resources 4.0 Know Physics of thermal, Tidal and Hydropower Energy Resources 5.0 Understand Photoelectrolyzers and Photosynthesis 6.0 Know Energy Conversion and Storage		

PROGRAMME: **NATIONAL RENEWABLE ENERGY TECHNOLOGY**						
COURSE TITLE: PHYSICS OF RE SYSTEMS		**COURSE CODE**: RET 112		Contact Hours: 2		
		Credit Unit: 2		Theoretical: 1		
Year: I Semester: I		Pre-requisite:		Practical: 1		
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to acquaint the students with the knowledge and skills of Physics application in Renewable Energy						
GENERAL OBJECTIVE 1.0: Understand the concept of Energy						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
	1.1 Define basic energy concepts: • Conservation • Transfer • Efficiency • Energy balance 1.2 List the basic forms of energy 1.3 Explain the following: • Energy conversion and utilization • Energy efficiency and losses.	Explain the following basic energy concepts: • Conservation • Transfer • Efficiency • Energy balance Explain the basic forms of energy Explain the following: • Energy conversion and utilization • Energy efficiency and losses.	Textbooks, Lecture notes, Journals Marker Markerboard PC Projector internet			

	1.4 List the primary energy sources. 1.5 Explain energy transfer processes 1.6 Explain the concept of energy and power 1.7 Explain energy flow and energy flow principles; • Primary energy • Secondary energy • Final energy • Useful energy	Explain the primary energy sources. Explain energy transfer processes Explain the concept of energy and power Explain energy flow and energy flow principles; • Primary energy • Secondary energy • Final energy • Useful energy				
General Objective 2.0: Understand Thermodynamics and Energy						
	2.1 Explain thermodynamics and energy relationship 2.2 Explain closed and open Systems: • Surroundings • Boundaries 2.3 Describe macroscopic and microscopic forms of energy	Explain thermodynamics and energy relationship Explain closed and open Systems: • Surroundings • Boundaries Discuss macroscopic and microscopic forms of energy Discuss the properties of a System	Textbooks, Lecture notes, Journals Marker Markerboard PC Projector internet			

	2.4 Describe the properties of a System 2.5 Explain the following; • State and equilibrium • Processes and Cycles • Pressure and temperature 2.6 Explain energy forms and their conversion processes	Explain the following: • State and equilibrium • Processes and Cycles • Pressure and temperature Explain energy forms and their conversion processes				
General Objective 3.0: Understand Physics of Solar and Wind Energy Resources						
	3.1 Explain the physics of Solar Energy. 3.2 Explain energy harvest from Solar 3.3 Explain the characteristics of solar radiation as an energy source 3.4 Explain conversion of the solar radiation to the electricity 3.5 Explain the basic processes in photovoltaics	Explain the physics of Solar Energy. Explain energy harvest from Solar Explain the characteristics of solar radiation as an energy source Explain conversion of the solar radiation to the electricity Explain the basic processes in	Textbooks, Lecture notes, Journals Marker Markerboard PC Projector internet	Test solar energy Plot the V-I characteristics of solar cell and determine the Fill Factor (FF) Measure the effect of PV panel temperature on output power generation	Guide students to: Test solar energy Plot the V-I characteristics of solar cell and determine the Fill Factor (FF) Measure the effect of PV panel temperature on output power generation	Multimeter Solar cells 10w solar panel Voltage probe Current probe Light sensor K-type thermocouple 1000w Tungsten halogen discharge lamp, Color filters

	• Photons • Photon Density of States (DOS) • Absorption, Reflection and Emission • Thermalization • Recombination • Separation and Extraction 3.6 Define Solar cells 3.7 List types of solar cells 3.8 Outline the characteristics of solar cells 3.9 Explain the efficiency limits of single junction solar cells 3.10 Explain the concept solar cell efficiency increase 3.11 Explain the fundamentals concept of Wind energy	photovoltaics • Photons • Photon Density of States (DOS) • Absorption, Reflection and Emission • Thermalization • Recombination • Separation and Extraction Explain Solar cells Explain types of solar cells Discuss the characteristics of solar cells Explain the efficiency limits of single junction solar cells Explain the concept solar cell efficiency increase Explain the fundamentals concept of Wind energy				

	3.12 Explain energy content of Wind 3.13 Describe the wind turbine construction. 3.14 Explain efficiency of Wind Turbines 3.15 Explain the horizontal and vertical wind turbines 3.16 Explain the following: • Types of Rotors • Drag-Type Rotors • Lift-Type Rotors	Explain energy content of Wind Explain the wind turbine construction. Explain efficiency of Wind Turbines Explain the horizontal and vertical wind turbines Explain the following: • Types of Rotors • Drag-Type Rotors • Lift-Type Rotors				
General Objective 4.0: Know Physics of Tidal, Hydropower and Geothermal Energy Resources						
	4.1 Explain ocean energy potential against wind and solar 4.2 Explain the basic concept of tidal Energy 4.3 Explain Solar and Luna tides	Explain ocean energy potential against wind and solar Explain the basic concept of tidal Energy Explain Solar and Luna tides Explain tidal characteristics	Textbooks, Lecture notes, Journals Marker Markerboard PC Projector internet	Simulate: • Tidal energy concepts • Hydropower energy concepts • Geothermal energy concepts	Guide students to Simulate: • Tidal energy concepts • Hydropower energy concepts • Geothermal energy concepts	Video clip Pictorial chart

	4.4 Explain tidal characteristics 4.5 Explain Tidal Energy Technologies 4.6 Explain ocean thermal energy 4.7 Explain the concept of osmotic power 4.8 Explain ocean biomass. 4.9 Explain the basic concept of geothermal energy 4.10 Explain geothermal technologies. 4.11 Explain the use of Geothermal Energy 4.12 Explain hydropower resources, 4.13 Explain basic concept of hydropower technologies	Explain Tidal Energy Technologies Explain ocean thermal energy Explain the concept of osmotic power Explain ocean biomass. Explain the basic concept of geothermal energy Explain geothermal technologies. Explain the use of Geothermal Energy Explain hydropower resources, Explain basic concept of hydropower technologies Explain the environmental impact of hydro power sources.				

General Objective 5.0: Understand Photoelectrolyzers and Photosynthesis						
	5.1 Explain the basic concept of Photoelectrolyzers 5.2 Explain the basic concept of Photosynthesis 5.3 Explain general considerations of biomass usage 5.4 Explain biophysical principles of photosynthesis 5.5 Explain basic biomolecular processes of photosynthesis 5.6 Explain photon absorption and energy transfer in the light-harvesting of photosystems	Explain the basic concept of Photoelectrolyzers Explain the basic concept of Photosynthesis Explain general considerations of biomass usage Explain biophysical principles of photosynthesis Explain basic biomolecular processes of photosynthesis Explain photon absorption and energy transfer in the light-harvesting of photosystems	Textbooks, Lecture notes, Journals Marker Markerboard PC Projector Internet			
General Objective 6.0: Know Energy Conversion and Storage						
	6.1 Explain the basic concept of Photoelectrolyzers	Explain the basic concept of Photo-electrolyzers Explain conversion of raw materials into usable energy	Textbooks, Lecture notes, Journals Marker Markerboard PC	Identify the types of batteries Identify the components of the batteries above Identify the following	Guide students to: Identify the types of batteries Identify the components of the batteries above	Capacitors Flywheels Pumped Hydropower Compressed Air Energy

	6.2 Explain conversion of raw materials into usable energy 6.3 Explain storage of the energy produced in energy conversion process 6.4 Explain the concept of electricity storage 6.5 Explain Storage technologies; • Batteries • Capacitors • Flywheels • Pumped Hydropower • Compressed Air Energy Storage (CAES) • Pumped Heat Electrical Storage (PHES) 6.6 Explain the basic concept of fuel cell 6.7 Explain the types of fuel cell technologies:	Explain storage of the energy produced in energy conversion process Explain the concept of electricity storage Explain Storage technologies; • Batteries • Capacitors • Flywheels • Pumped Hydropower • Compressed Air Energy Storage (CAES) • Pumped Heat Electrical Storage (PHES) Explain the basic concept of fuel cell Explain the types of fuel cell technologies: • Proton Exchange Membrane Fuel Cells	Projector internet	storage systems: • Capacitors • Flywheels • Pumped Hydropower • Compressed Air Energy Storage (CAES) • Pumped Heat Electrical Storage (PHES)	Identify the following storage systems: • Capacitors • Flywheels • Pumped Hydropower • Compressed Air Energy Storage (CAES) • Pumped Heat Electrical Storage (PHES)	Storage (CAES) Pumped Heat Electrical Storage (PHES)

	• Proton Exchange Membrane Fuel Cells • Phosphoric Acid Fuel Cells • Solid Oxide Fuel Cells	• Phosphoric Acid Fuel Cells • Solid Oxide Fuel Cells				
ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 60% of the total score. The end of the Semester Examination will make up for the remaining 40% of the total score.						

Basic Chemistry for Renewable Energy System

PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY		
COURSE TITLE: **Basic Chemistry for Renewable Energy System**	Course Code: RET 113	Contact Hours: 2
	Credit Unit: 2	Theoretical: 1
Year: I Semester: I	Pre-requisite:	Practical: 1Hour/week
GOAL: This course is designed to acquaint students with the knowledge and skills on the applications of chemistry to renewable energy		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the basic chemistry of biomass and biofuels 2.0 Understand the basic chemistry of solar energy 3.0 Understand the basic chemistry of hydrogen and fuel cells 4.0 Know Renewable Energy storage and materials chemistry 5.0 Understand the basic concepts of sustainable (green) chemistry and carbon capture		

PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY						
COURSE TITLE: **Basic Chemistry for Renewable Energy System**		Course Code: RET 113		Contact Hours: 2		
		Credit Unit: 2		Theoretical: 1		
Year: I Semester: I		Pre-requisite:		Practical: 1Hour/week		
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to acquaint the students with the knowledge and skills on the applications of chemistry to renewable energy						
GENERAL OBJECTIVE 1.0: Understand the basic chemistry of biomass and biofuels						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Explain composition and properties of biomass 1.2 Explain extraction and characterization of biomass components: • Cellulose • Hemicellulose • Lignin, etc. 1.3 Explain the biomass conversion processes: • Thermochemical (gasification, pyrolysis) • Biological (fermentation, anaerobic digestion)	Explain composition and properties of biomass Explain extraction and characterization of biomass components: • Cellulose • Hemicellulose • Lignin, etc. Explain the biomass conversion processes: • Thermochemical (gasification, pyrolysis) • Biological (fermentation,	Textbooks, Lecture notes, Journals Marker Markerboard PC Projector internet	Identify the various sources to produce biodiesel, bioethanol and biogas Demonstrate simple fermentation, transesterification and anerobic digestion processes for the conversion of biomass into biofuels	Guide students to: Identify the various sources to produce biodiesel, bioethanol and biogas Demonstrate simple fermentation, transesterification and anerobic digestion processes for the conversion of biomass into biofuels	Feedstock Laboratory chemicals and reagents,

	• Chemicals and fuels obtained from biofuels 1.4 Explain the basic chemistry of biofuels: • Bioethanol • Biodiesel • Biogas, • Briquettes • Bio-oil 1.5 Explain performance properties of biofuels	anaerobic digestion) • Chemicals and fuels obtained from biofuels Explain the basic chemistry of biofuels: • Bioethanol • Biodiesel • Biogas, • Briquettes • Bio-oil Explain performance properties of biofuels				
General Objective 2.0: Understand the basic chemistry of solar energy						
4-5	2.1 Define Electrochemistry 2.2 Explain Electrochemical Processes with relevance to energy conversion 2.3 Describe electrochemistry of batteries 2.4 Explain electrochemistry of fuel cells 2.5 Explain electrochemistry of solar cells	Explain Electrochemistry Explain Electrochemical Processes with relevance to energy conversion Discuss electrochemistry of batteries Explain electrochemistry of fuel cells Explain electrochemistry of solar cells	Textbooks, Lecture notes, Journals Marker Markerboard PC Projector internet			

	2.6 Explain electrochemical techniques that can be used to study • Batteries, • Solar cells 2.7 Explain photovoltaic chemistry: • Define Semiconductor • Describe types of semiconductors 2.8 Explain the differences between semiconductors and Conductors 2.9 Explain materials for semiconductors and solar cells 2.10 Define Solar Cells 2.11 Explain the types of Solar cells • Crystalline silicon • Thin film solar cell • Organic photovoltaic cell	Explain electrochemical techniques that can be used to study • Batteries, • Solar cells Explain photovoltaic chemistry: • Define Semiconductor • Describe types of semiconductors Discuss the differences between semiconductors and Conductors Explain materials for semiconductors and solar cells Explain Solar Cells Explain the types of Solar cells • Crystalline silicon • Thin film solar cell				

	2.12 Explain chemical mechanism of solar energy conversion	• Organic photovoltaic cell Explain chemical mechanism of solar energy conversion				
General Objective 3.0: Understand the basic chemistry of hydrogen and fuel cells						
6-8	3.1 Explain the chemistry of hydrogen production: • Water hydrolysis • Biomass gasification • Hydrogen handling (storage and transportation) 3.2 Define Fuel Cells 3.3 Explain types of fuel cells: • Proton exchange membrane fuel cell (PEMFC) • Direct methanol fuel cells (DMFC) • Phosphoric acid fuel cells (PAFC) • Solid oxide fuel cells (SOFC) • Molten carbonate fuel cells (MCFC)	Explain the chemistry of hydrogen production: • Water hydrolysis • Biomass gasification • Hydrogen handling (storage and transportation) Explain Fuel Cells Explain types of fuel cells: • Proton exchange membrane fuel cell (PEMFC) • Direct methanol fuel cells (DMFC) • Phosphoric acid fuel cells (PAFC)	Textbooks, Lecture notes, Journals Marker Markerboard PC Projector internet			

	3.4 Explain the areas of fuel cells application	• Solid oxide fuel cells (SOFC) • Molten carbonate fuel cells (MCFC) Explain the areas of fuel cells application				
General Objective 4.0: Know Renewable Energy storage and materials chemistry						
9-11	4.1 Define battery 4.2 Explain different types of batteries • ***Primary batteries*** (zinc carbon cells, alkaline batteries, silver oxide batteries, zinc air, lithium batteries, etc) • ***Secondary batteries*** (Lead acid batteries, Nickel Cadmium batteries, Lithium-ion batteries and lithium polymer batteries) 4.3 State the properties of Primary and secondary batteries and their uses	Explain battery Explain different types of batteries • ***Primary batteries*** (zinc carbon cells, alkaline batteries, silver oxide batteries, zinc air, lithium batteries, etc) • ***Secondary batteries*** (Lead acid batteries, Nickel Cadmium batteries, Lithium-ion batteries and lithium polymer batteries)	Textbooks, Lecture notes, Journals Marker Markerboard PC Projector internet	Identify different types of battery Measure battery efficiency parameters	Guide the students to Identify different types of battery Measure battery efficiency parameters measure battery quality parameters	Batteries and measuring devices

	4.4 Explain the materials for battery electrodes and electrolytes 4.5 Define super capacitors 4.6 Explain types of supercapacitors 4.7 Explain the mechanism of RE storage	Explain the properties of Primary and secondary batteries and their uses Explain the materials for battery electrodes and electrolytes Explain super capacitors Explain types of supercapacitors Explain the mechanism of RE storage				
General Objective 5.0: Understand the basic concepts of sustainable (green) chemistry and carbon capture						
12-14	5.1 Define Green Chemistry 5.2 Explain sustainable chemical processes 5.3 Explain bioplastics production from biomaterials 5.4 Explain the concept of Carbon Capture 5.5 Explain the chemical process of Carbon capture 5.6 Describe the materials for Carbon storage	Explain Green Chemistry Explain sustainable chemical processes Explain bioplastics production from biomaterials Explain the concept of Carbon Capture Explain the chemical process of Carbon capture	Textbooks, Lecture notes, Journals Marker Markerboard PC Projector internet			

		Discuss the materials for Carbon storage				
ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 60% of the total score. The end of the Semester Examination will make up for the remaining 40% of the total score						

RENEWABLE ENERGY AND ENVIRONMENT

PROGRAMME: NATIONAL DIPLOMA IN RENEWABLE ENERGY		
COURSE TITLE: RENEWABLE ENERGY AND ENVIRONMENT	Course Code: RET 121	Contact Hours: 3HRS/WK
	Credit Units: 3	Theoretical: 1
Year: I Semester: II	Pre-requisite: NIL	Practical: 2 Hours/week
Goal: This course is designed to equip students with the knowledge and skills of the different renewable energy sources and their respective effects on the environment.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the concept of environment 2.0 Know the different renewable energy sources 3.0 Understand the relationship between RE sources and the environment 4.0 Understand the management of RE solid wastes and their effects on the environment 5.0 Understand the health effects of basic utilities and work environments 6.0 Understand the basic principles of environmental impact assessment (EIA)		

PROGRAMME: **NATIONAL DIPLOMA IN RENEWABLE ENERGY**						
COURSE TITLE: RENEWABLE ENERGY AND ENVIRONMENT		**COURSE CODE**: RET 121		Contact Hours: 3HRS/WK		
		Credit Unit: 3		Theoretical: 1		
Year: I Semester: II		Pre-requisite: NIL		Practical: 2 Hours/week		
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with the knowledge and skills of the different renewable energy sources and their respective effects on the environment.						
GENERAL OBJECTIVE 1.0: Understand the concept of environment						
THEORETICAL CONTENT				**PRACTICAL CONTENT**		
Week	**Specific Learning Outcome**	**Teacher's Activities**	**Resources**	**Specific Learning Outcome**	**Teacher's Activities**	**Resources**
1-2	1.1 Define Environment 1.2 Explain the concept of Environmental health 1.3 Explain the different types of environment: • Physical environment • Biological environment • Chemical environment • Social or cultural environment 1.4 Explain the following ; • Carbon Emission	Explain Environment Explain the concept of Environmental health Explain the different types of environment: • Physical environment • Biological environment • Chemical environment	Textbooks, Lecture notes, Journals Marker Markerboard PC Projector internet	Detect the prevalent environmental conditions in the immediate environment.	Guide students to: Measure different environmental parameters.	Thermometer, Barometer, temperature probes air velocity meter, solar irradiation sensor, Pyranometer

	• Client Change and • global warming	• Social or cultural environment Explain the following ; • Carbon Emission • Client Change and • global warming				
General Objective 2.0: Know the different renewable energy sources						
3-4	2.1 Explain renewable energy sources obtainable from: • Physical environment • Biological environment • Chemical environment • Social or cultural environment 2.2 Explain the operation of different Renewable energy sources, in relation to; • Natural landscape • Environmental	Explain renewable energy sources obtainable from: • Physical environment • Biological environment • Chemical environment • Social or cultural environment	Textbooks, Lecture notes, Journals Marker Markerboard PC Projector internet	Visit different RE sites to have practical experience and be introduced to relevant equipment.	Guide students to: Identify various renewable energy sources and their associated equipment setup.	Solar panels, batteries, charge controllers, inverters, biodigester, DC bulbs, cables, solar thermal collector, portable wind mill

	Protection • Natural landscape • Environmental Protection 2.3 Explain the operation of Renewable Energy, as solution to; • Carbon Emission • Climate Change • Global Warming 2.4 Explain the following Biological resources as renewable energy sources; • Plants • Animal Waste • Organic Waste,etc	Explain the operation of different Renewable energy sources, in relation to; • Natural landscape • Environmental Protection • Natural landscape • Environmental Protection Explain the operation of Renewable Energy, as solution to; • Carbon Emission • Climate Change • Global Warming Explain the following Biological resources as renewable energy sources; • Plants • Animal Waste • Organic				

		Waste, etc				
General Objective 3.0: Understand the relationship between RE sources and the environment						
5-7	3.1 Explain the basic concept of RE sources and environment relationship 3.2 Explain the differences between the Quality and quantity of sun for different environments 3.3 Explain the differences between quality and quantity of wind for different environments 3.4 Explain the topography of water bodies/site 3.5 Explain the different types of waste available on site 3.6 Explain the reduction of the usage of fossil fuels and carbon emissions 3.7 Explain the reduction of dependence on fossil fuels	Explain the basic concept of RE sources and environment relationship Explain the differences between the Quality and quantity of sun for different environments Explain the differences between quality and quantity of wind for different environments Explain the topography of water bodies/site Explain the different types of waste available on site	Textbooks, Lecture notes, Journals Marker Markerboard PC Projector internet	Establish the relationship and interaction between RE sources and different environments.	Conduct assessment on the different environments.	Solar irradiation sensor, tachometer, manometer, anemometer, biodigester, pulverizer,

	3.8 Explain the impact of 3.6 on irrigation farming and erosion control 3.9 Explain the reduction of organic waste.	Explain the reduction of the usage of fossil fuels and carbon emissions Explain the reduction of dependence on fossil fuels Explain the impact of 3.6 on irrigation farming and erosion control Explain the reduction of organic waste.				
General Objective 4.0: Understand the management of RE solid wastes and their effects on the environment						
8-9	4.1 Define solid wastes 4.2 Explain the effects of RE solid wastes on the environment 4.3 Explain the means of recycling electronic wastes, digestate/effluent, etc.	Explain solid wastes Explain the effects of RE solid wastes on the environment Explain the means of recycling electronic wastes, digestate/effluent, etc.	Textbooks, Lecture notes, Journals Marker Markerboard PC Projector internet			

General Objective 5.0: Understand the health effects of basic utilities and work environments						
10-12	5.1 Explain the effects of ventilation, lighting, artificial illumination on human health. 5.2 Describe the industrial hazards in working environment. 5.3 State the methods of control of occupational health hazards.	Explain the effects of ventilation, lighting, artificial illumination on human health. Discuss the industrial hazards in working environment. Explain the methods of control of occupational health hazards.	Textbooks, Lecture notes, Journals Marker Markerboard PC Projector internet			
General Objective 6.0: Understand the basic principles of environmental impact assessment (EIA)						
13-15	6.1 Define Environmental impact assessment (EIA) 6.2 Outline the basic steps in EIA 6.3 Explain Environmental Impact Statement (EIS). 6.4 Explain environmental audits. 6.5 Describe EIA and EIS for any two different projects	Explain Environmental impact assessment (EIA) Outline the basic steps in EIA Explain Environmental Impact Statement (EIS).	Textbooks, Lecture notes Journals Marker Markerboard PC Projector internet	Prepare EIA and EIS for any two different projects within the campus	Guide students to: Prepare EIA and EIS for any two different projects within the campus	Sample EIA Sample EIS

		Explain environmental audits. Explain EIA and EIS for any two different projects				
ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 60% of the total score. The end of the Semester Examination will make up for the remaining 40% of the total score						

Introduction to Digital Electronics

PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY		
COURSE TITLE: Introduction to Digital Electronics	**COURSE CODE:** RET 122	**CONTACT HOURS:** 3
	CREDIT UNIT: 3	**THEORETICAL:** 2
YEAR: I **SEMESTER:** I	**PRE-REQUISITE:**	**PRACTICAL:** 1
GOAL: This course is designed to equip student with the knowledge and skills of digital electronics system		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Know the basic concept of Number System 2.0 Understand Logic Gates 3.0 Know Logic Simplification and its Applications 4.0 Know Multiplexers and De-Multiplexers 5.0 Understand Latches, flip-flops, and Counters 6.0 Understand Microcontrollers and Programming		

PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY		
COURSE TITLE: Introduction to Digital Electronics	**COURSE CODE:** RET 122	**CONTACT HOURS:** 3
	CREDIT UNIT: 3	**THEORETICAL:** 2
YEAR: I **SEMESTER:** I	**PRE-REQUISITE:**	**PRACTICAL:** 1
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL		
GOAL: This course is designed to equip student with the knowledge and skills of digital electronics system		
General Objective 1.0: Know the basic concept of Number System		

THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Explain analog and digital signals 1.2 Explain applications of digital and analog signals. 1.3 Explain the advantages of analog and digital signals. 1.4 Explain binary, octal, and hexadecimal number system 1.5 Explain conversion from decimal and hexadecimal to binary and vice-versa.	Explain analog and digital signals Explain applications of digital and analog signals. Explain the advantages of analog and digital signals Explain binary, octal, and hexadecimal number system Explain conversion from decimal and hexadecimal to binary and vice-versa.	Textbooks Journals Charts Animations Computer Projector Marker Marker Board	Demonstrate conversion from decimal and hexadecimal	Guide students to: Demonstrate conversion from decimal and hexadecimal	Digital Logic Trainers DMM. Bench Power Supply. Function Generator. Breadboard. Oscilloscope.

	1.6 Explain binary addition and subtraction 1.7 Explain the addition/subtraction of 1's and 2's complement	Explain binary addition and subtraction, Explain the addition/subtraction of 1's and 2's complement				
General Objective 2.0: Understand Logic Gates						
4-6	2.1 Explain logic gate 2.2 Explain the basic concept of negative and positive logic, 2.3 Define truth table. 2.4 Explain the symbols and truth tables of NOT, AND, OR, NAND, NOR, EXOR Gates 2.5 Describe the NAND and NOR as universal gates. 2.6 Explain interpretation truth tables for logic gates 2.7 Describe the integrated circuit logic	Explain logic gate Explain the basic concept of negative and positive logic, Explain truth table. Explain the symbols and truth tables of NOT, AND, OR, NAND, NOR, EXOR Gates Explain the NAND and NOR as universal gates. Explain interpretation truth tables for logic gates Explain the integrated circuit logic	Textbooks Journals Computer Internet Projector Marker Marker Board	Investigate the logical behavior of AND, OR, NOT, NAND, NOR, and EX-OR gates. Show the NAND gate as a Universal Gate Interpret truth tables for logic gates	Guide Students to: Investigate the logical behavior of AND, OR, NOT, NAND, NOR, and EX-OR gates. Demonstrate and show the NAND gate as a Universal Gate Interpret truth tables for logic gates	Digital Logic Trainer. Logic gates. DMM. Bench Power Supply. Digital Logic Trainer. Function Generator. Breadboard. Oscilloscope.

	2.8 Explain the concept of integrated circuit Logic families. 2.9 Explain the TTL and CMOS logic families	Explain the concept of integrated circuit Logic families. Explain the TTL and CMOS logic families				
General Objective 3.0: Know Logic Simplification and its Applications						
7-8	3.1 Explain the concept of Boolean algebra 3.2 Explain the implementation of the Boolean (logic) equation with gates 3.3 Explain Karnaugh map up to 4 variables 3.4 Explain the simplicity of Karnaugh map application in developing combinational logic circuits 3.5 Explain the half-adder and full-adder circuit 3.6 Explain the half and full subtractor circuit.	Explain the concept of Boolean algebra Explain the implementation of the Boolean (logic) equation with gates Explain Karnaugh map up to 4 variables Explain the simplicity of Karnaugh map application in developing combinational logic circuits Explain the half-adder and full-adder circuit Explain the half and full subtractor circuit.	Textbooks Journals Computer Internet Projector Marker Marker Board	Verify Boolean Laws using the various logic gates Construct the truth table of various logic gates and combination circuits using logic gates. Evaluate various combinational circuits such as adders, subtractors, Design and implement adders and subtractors using logic gates Implement adders and subtractors using logic gates	Guide the students to: Verify Boolean Laws using the various logic gates Construct the truth table of various logic gates and combination circuits using logic gates. Design, test, and evaluate various combinational circuits such as adders, subtractors, Design and implementation of adders and subtractors using logic gates	Digital Logic Trainer. Logic gates. DMM. Bench Power Supply. Function Generator Breadboard. Oscilloscope.

	3.7 Explain the design and implementation of half and full subtractor circuits using the Karnaugh map 3.8 Explain the design and implementation of half and full subtractor circuits using the Karnaugh map	Explain the design and implementation of half and full subtractor circuits using the Karnaugh map Explain the design and implementation of half and full subtractor circuits using the Karnaugh map		Design and implement of 4-bit binary adder/subtractor and BCD adder using digital ICs Implement of 4-bit binary adder/subtractor and BCD adder using digital ICs	Design and implementation of 4-bit binary adder/subtractor and BCD adder using digital ICs	
General Objective 4.0: Know Multiplexers and De-Multiplexers						
9-11	4.1 Explain multiplexers and de-multiplexers 4.2 Explain the basic functions and block diagram of multiplexers and de-multiplexers 4.3 Explain the different types and IC configurations. 4.4 Explain interpretation of truth tables for multiplexers and de-multiplexers	Explain multiplexers and de-multiplexers Explain the basic functions and block diagram of multiplexers and de-multiplexers Explain the different types and IC configurations. Explain interpretation of truth tables for multiplexers and de-multiplexers	Textbooks Journals Computer Internet Projector Marker Marker Board	Interpret truth tables for multiplexers and de-multiplexers Implement multiplexer and demultiplexer using logic gate Design multiplexer and demultiplexer using logic gates and study of IC 74150 and IC 74154	Guide the students to: Interpret truth tables for multiplexers and de-multiplexers Implement multiplexer and demultiplexer using logic gate Design multiplexer and demultiplexer using logic gates and study of IC 74150 and IC 74154	Digital Logic Trainer. Logic gates. DMM. Bench Power Supply. Function Generator Breadboard. Oscilloscope

General Objective 5.0: Understand Latches, flip-flops, and Counters						
12-13	5.1 Describe the concept of the latch and flip-flop 5.2 Explain the difference between a latch and a flip-flop 5.3 Explain the working principle of latch 5.4 Explain the types of latches 5.5 Explain the applications of latches 5.6 Describe the circuit structure of different flip flops and their applications 5.7 Explain the operation of T, D, and Master/Slave JK flip flops using waveforms and truth tables. 5.8 Explain the basic concept of counters	Explain the concept of the latch and flip-flop Explain the difference between a latch and a flip-flop Explain the working principle of latch Explain the types of latches Explain the applications of latches Explain the circuit structure of different flip flops and their applications Explain the operation of T, D, and Master/Slave JK flip flops using waveforms and truth tables. Explain the basic concept of counters	Textbooks Journals Computer Internet Projector Marker Marker Board	Evaluate flip-flops, counters, and shift registers. Implement SISO, SIPO, PISO, and PIPO shift registers using flip-flops. Verify of 4-bit ripple counter and Mod-10, Mod-12, and Mod-N ripple counters Simulate various combinational circuits, sequential circuits flip-flops, and counters. using relevant software Interpret Truth Tables for latches, flip flops, and counters	Guide students to: Construct, test, and evaluate flip-flops, counters, and shift registers. Implement SISO, SIPO, PISO, and PIPO shift registers using flip-flops. Construct, test, and verify of 4-bit ripple counter and Mod-10, Mod-12, and Mod-N ripple counters Simulate various combinational circuits, sequential circuits flip-flops, and counters. using relevant software Interpret Truth Tables for latches, flip flops, and counters	Digital Logic Trainer. IC TRAINER kit Bench Power Supply Logic Gates, Oscilloscope Connecting Probes Logic gates. DMM. Bench Power Supply. Function Generator Breadboard. Oscilloscope

	5.9 Explain the following counters: • asynchronous and synchronous counters • Binary counters • Divide by N ripple counters • Decade counter • Timers • Shift registers 5.10 Explain how to interpret truth tables for latches, flip flops, and counters	Explain the following counters: • asynchronous and synchronous counters • Binary counters • Divide by N ripple counters • Decade counter • Timers • Shift registers Explain how to interpret truth tables for latches, flip flops, and counters				
General Objective 6.0: Understand Microcontrollers and Programming						
14-15	6.1 Explain the Concept Microcontrollers. 6.2 Explain the Architecture of the following Microcontrollers; • Arduino Uno • Rasbery Pi • ATMEGAS and • PIC 6.3 Define Microcontroller Programming	Explain the Concept Microcontrollers. Explain the Architecture of the following Microcontrollers; • Arduino Uno • Rasbery Pi • ATMEGAS and • PIC Explain Microcontroller Programming	Textbooks Journals Computer Internet Projector Marker Marker-Board	Identify the Microcontrollers. Identify Microcontroller Input/Output ports, power pins, reset and clock pins. Perform Basic Programming. Load the program from	Guide the students to: Identify the Microcontrollers. Identify Microcontroller Input/Output ports, power pins, reset and clock pins. Perform Basic Programming. Load the program	Computer Arduino Uno kits Rasbery Pi Microcontroller Trainer. IC Programmer. Bench Power supply.

	6.4 Explain Microcontroller Programming
	• Instruction set
	• Programming Language
	  • C++
	  • Python
	
	6.5 Explain how to interface with microcontrollers and sensors
	
	6.6 Explain how to interface microcontrollers with ADC, DAC, or other microcontrollers
		Explain Microcontroller Programming
		• Instruction set
		• Programming Language
		  • C++
		  • Python
		
		Explain how to interface with microcontrollers and sensors
		
		Explain how to interface microcontrollers with ADC, DAC, or other microcontrollers
				PC to microcontroller via programmer.
				
				Setup the hardware (vero board, breadboard, microcontroller, led, sensors, e.t.c)
				
				Interface microcontrollers with sensors.
					from PC to microcontroller via programmer.
					
					Setup the hardware (vero board, breadboard, microcontroller, led, sensors, e.t.c)
					
					Interface microcontrollers with sensors.
						Breadboard.
						
						Vero Board.
						
						Serial Cable.
						
						Sensors.
						
						Soldering kits.
						
						Computer with appropriate software

ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 60% of the total score. The end of the Semester Examination will make up for the remaining 40% of the total score						

RENEWABLE ENERGY INSTALLATION AND MAINTENANCE I

PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY		
COURSE TITLE: RENEWABLE ENERGY INSTALLATION AND MAINTENANCE I	Course Code: RET 211	Contact Hours: 3
	Credit Unit: 3	Theoretical: 1
Year: II Semester: I	Pre-requisite:	Practical: 2Hour/week
GOAL: This course is designed to equip the students with basic knowledge and skills to install and Maintain Renewable Energy System.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the fundamentals of RE system installation and maintenance 2.0 Know basic RE System Installation Techniques 3.0 Know basic RE System Maintenance Techniques. 4.0 Understand Troubleshooting and Maintenance		

PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY						
COURSE TITLE: RENEWABLE ENERGY INSTALLATION AND MAINTENANCE I		Course Code: RET 211		Contact Hours: 3		
		Credit Unit: 3		Theoretical: 1		
Year: II Semester: I		Pre-requisite:		Practical: 2Hour/week		
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip tudents with basic knowledge and skills to install and Maintain Renewable Energy System.						
General Objective 1.0 Understand the fundamentals of RE system installation and maintenance						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Define installation in RE system 1.2 Define maintenance in RE system 1.3 Explain the role of installation and maintenance in RE system 1.4 Explain RE system components 1.5 Explain RE codes and regulations	Explain installation in RE system Explain Installation maintenance in RE system Explain the role of installation and maintenance in RE system Explain RE system components Explain RE codes and regulations	Textbook Journal PC Projector Marker Marker Board Internet	Identify Graphical symbols in installation of RE system Draft RE Symbols Using RE Software Produce wiring/connection diagram for RE system	Guide students to: Identify Graphic symbols in installation of RE system Draft RE Schematic Symbols Using RE Software Produce wiring/connection diagram for RE system	Drawing instruments Computers AUTO-CAD Electrical, VISIO Multisim EdrawMax Smart Draw

	1.6 Explain safety practices in RE installations 1.7 Explain energy efficiency in RE systems Explain Safety Measures in RE Testing and Inspection	Explain safety practices in RE installations Explain energy efficiency in RE systems Explain Safety Measures in RE Testing and Inspection				
General Objectives 2.0 Know basic RE System Installation Techniques						
3-6	2.1 Explain Installation of RE Wiring Systems 2.2 Explain Installation of RE Protection Devices 2.3 Explain Installation of RE Appliances and Equipment 2.4 Explain RE System inspection and testing inspection	Explain Installation of RE Wiring Systems Explain Installation of RE Protection Devices Explain Installation of RE Appliances and Equipment Explain RE System inspection and testing inspection	Textbook Journal PC Projector Marker Marker Board Internet	Draw the wiring diagram of RE system Connect RE Protective Devices Connect RE Appliances and Equipment Carry out inspection and testing of RE installation	Guide students to: Draw the wiring diagram of RE system Connect RE Protective Devices Connect RE Appliances and Equipment Carry out inspection and testing of RE installation	PPE Multimeter Electrical and mechanical Tool kit
GENERAL OBJECTIVE 3.0: Know basic RE System Maintenance Techniques.						
7-11	3.1 Explain how to Set up a basic RE maintenance Plan	Explain how to Set up a basic RE maintenance Plan	Textbook Journal PC Projector Marker	Identify RE Codes and regulations	Guide students to: Identify RE Codes and regulations	PPE IEE regulations

	3.2 Explain preventive and other maintenance strategies 3.3 Explain routine inspection and testing. 3.4 Explain equipment lubrication and cleaning. 3.5 Explain RE system troubleshooting methods. 3.6 Explain the use of RE diagnostic tools and instruments 3.7 Explain RE codes and regulations 3.8 Explain Maintenance of RE Protection Devices 3.9 Explain the maintenance of RE Appliances and Equipment	Explain preventive and other maintenance strategies Explain routine inspection and testing. Explain equipment lubrication and cleaning. Explain RE system troubleshooting methods. Explain the use of RE diagnostic tools and instruments Explain RE codes and regulations Explain Maintenance of RE Protection Devices Explain the maintenance of RE Appliances and Equipment	Marker Board Internet	Develop a simple maintenance plan for RE system Demonstrate lubrication and cleaning of RE equipment. Demonstrate the use of RE diagnostic tools and instruments Carryout maintenance of RE Appliances and Equipment	Develop a simple maintenance plan for RE system Troubleshoot a basic fault in RE system Demonstrate lubrication and cleaning of RE equipment. Demonstrate the use of RE diagnostic tools and instruments Carryout maintenance of RE Appliances and Equipment	Troubleshooting guides sample RE maintenance plan tool kits
OBJECTIVE 4.0: Understand basic RE Systems Troubleshooting						
12-14	4.1 Explain troubleshooting in RE installation	Explain troubleshooting in RE installation	Textbook Journal PC Projector			

	4.2 List troubleshooting methods in RE installation • Regular cleaning and inspection • Addressing potential issues • Performance Data Analysis • Electrical Testing 4.3 List Maintenance measures Renewable Energy Installations: • General check • Cleaning • Data monitoring • Electrical testing	List troubleshooting methods in RE installation • Regular cleaning and inspection • Addressing potential issues • Performance Data Analysis • Electrical Testing Explain Maintenance measures Renewable Energy Installations: • General check • Cleaning • Data monitoring • Electrical testing	Marker Marker Board Internet			
ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 60% of the total score. The end of the Semester Examination will make up for the remaining 40% of the total score.						

RENEWABLE ENERGY TECHNOLOGY AND APPLICATION I

PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY		
COURSE TITLE: RENEWABLE ENERGY TECHNOLOGY AND APPLICATION I	Course Code: RET 212	Contact Hours: 3
	Credit Unit: 3	Theoretical: 1
Year: II Semester: I	Pre-requisite:	Practical: 2Hour/week
GOAL: This course is designed to acquaint students with the knowledge and skills of basic Renewable Energy technology and applications		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand Basic Concepts of Renewable Energy Technology 2.0 Know Basic Solar Energy Technology 3.0 Know Basic Wind Energy Technology 4.0 Understand Basic Geothermal & Hydroelectric Energy Technology 5.0 Know Basic Biomass Technology 6.0 Understand Other Renewable Energy Technology		

PROGRAMME: **NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY**						
COURSE TITLE: RENEWABLE ENERGY TECHNOLOGY AND APPLICATION I		**COURSE CODE**: RET 212		Contact Hours: 3		
		Credit Unit: 2		Theoretical: 1		
Year: I Semester: I		Pre-requisite:		Practical: 2		
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip students with knowledge and skills of Renewable Energy Technology						
GENERAL OBJECTIVE 1.0: Understand Basic Concepts of Renewable Energy Technology						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-2	1.1 Explain renewable energy technologies. 1.2 Explain the history of renewable energy technologies. 1.3 Describe types of renewable energy technologies. 1.4 Explain criteria for developing and using renewable technologies.	Explain renewable energy technologies. Explain the history of renewable energy technologies. Explain types of renewable energy technologies. Explain criteria for developing and using renewable technologies.	Textbook Journal PC Projector Marker Marker Board Internet	Identify kinds of renewable energy technologies.	Guide students to: Identify different kinds of renewable energy technologies	Video Clips

General Objective 2.0: Know Solar Energy Technology						
3-5	2.1 Define solar energy 2.2 Explain the process of Solar Energy harnessing 2.3 Explain passive solar and active solar energy. 2.4 Explain the following: • Solar constant • Solar radiation geometry • Local solar time • Day length 2.5 Describe the following: • Solar radiation measurement • Radiation on inclined surface • Solar charts 2.6 Explain Photovoltaic systems 2.7 Explain photovoltaic cells and solar thermal system	Explain solar energy Explain the process of Solar Energy harnessing Explain passive solar and active solar energy. Explain the following: • Solar constant • Solar radiation geometry • Local solar time • Day length Explain the following: • Solar radiation measurement • Radiation on inclined surface • Solar charts Explain Photovoltaic systems	Textbook Journal PC Projector Marker Marker Board Internet	Measure solar radiation Connect solar cells in series and parallel. Simulate concentrating solar power technologies (CSP)		Pyranometer Relevant software

	2.8 Explain concentrating solar power technologies concept.	Explain photovoltaic cells and solar thermal system Explain concentrating solar power technologies concept.				
General Objective 3.0: Know Wind Energy Technology						
6-8	3.1 Explain wind energy 3.2 Describe factors that affect harnessing wind energy. 3.3 Explain kinetic energy. 3.4 Explain power generation in the wind turbine. 3.5 Explain horizontal and vertical axis turbine 3.6 Explain wind turbine performance 3.7 Explain wind turbine energy production	Explain wind energy Discuss factors that affect harnessing wind energy. Explain kinetic energy. Explain power generation in the wind turbine. Explain horizontal and vertical axis turbine Explain wind turbine performance	Textbook Journal PC Projector Marker Marker Board Internet	Identify the wind Turbine Identify horizontal and vertical axis machines Measure wind turbine energy generation	Guide students to: Identify the wind Turbine Identify horizontal and vertical axis machines Measure wind turbine energy generation	Wind turbine demonstration module, Anemometer Multimeter Videos

	3.8 Explain: • Wind farms • Environmental impact 3.9 Outline the advantages and disadvantages of wind energy.	Explain wind turbine energy production Explain: • Wind farms • Environmental impact Discuss the advantages and disadvantages of wind energy.				
General Objective 4.0:Understand Geothermal & Hydroelectric Energy Technology						
9-10	4.1 Explain geothermal system & their characteristics. 4.2 Explain types of geothermal energy. 4.3 Explain: • Solar thermal • Geothermal • Heat pumps 4.4 Explain the generation of hydroelectric energy.	Explain geothermal system & their characteristics. Explain types of geothermal energy. Explain: • Solar thermal • Geothermal • Heat pumps Explain the generation of hydroelectric energy.	Textbook Journal PC Projector Marker Marker Board Internet			

	4.5 Explain factors that influence geothermal and hydroelectric energy. 4.6 Explain the advantages and disadvantages of the following technologies: • Geothermal • Hydroelectric	Explain factors that influence geothermal and hydroelectric energy. Explain the advantages and disadvantages of the following technologies: • Geothermal • Hydroelectric				
General Objective 5.0: Know Biomass Technology						
11-12	5.1 Explain the heat content of biofuels 5.2 Explain biomass conversion technologies. 5.3 Describe aerobic and anaerobic digester 5.4 Explain factors affecting bio-digestion 5.5 Describe types of Biogas plants 5.6 Explain the utilization of biogas	Explain the heat content of biofuels Explain biomass conversion technologies. Discuss aerobic and anaerobic digester Explain factors affecting bio-digestion Explain types of Biogas plants	Textbook Journal PC Projector Marker Marker Board Internet	Identify any biofuels plants Identify the components of any of the following plants: • Biogas • Biodiesel • Bioethanol	Guide students to: Identify any biofuels plants Identify the components of any of the following plants: • Biogas • Biodiesel • Bioethanol	Video Clips

	5.7 Explain Biomass gasification 5.8 Outline the advantages and disadvantages of biofuels	Explain the utilization of biogas Explain Biomass gasification Discuss the advantages and disadvantages of biofuels				
General Objective 6.0: Understand Other Renewable Energy Technology						
13-14	6.1 Explain Tidal energy in relation to: • Principles of tidal power. • Sources of tidal power. • Wave power converters • Harnessing tidal power • Integration for electrical power transfer. 6.2 Explain Hydrogen energy in relation to: • Principle of Fuel Cells • Classification of fuel cells	Explain Tidal energy in relation to: • Principles of tidal power. • Sources of tidal power. • Wave power converters • Harnessing tidal power • Integration for electrical power transfer. Explain Hydrogen energy in relation to: • Principle of Fuel Cells				

	• Conversion • Efficiency • Polarization of fuel cells 6.3 Explain Magneto Hydrodynamic (MHD) power conversion in relation to: • Principle of MHD power conversion • Types • Closed and open cycle system • MHD Materials. 6.4 Explain Ocean Thermal Energy Conversion (OTEC).	• Classification of fuel cells • Conversion • Efficiency • Polarization of fuel cells Explain Magneto Hydrodynamic (MHD) power conversion in relation to: • Principle of MHD power conversion • Types • Closed and open cycle system • MHD Materials. Explain Ocean Thermal Energy Conversion (OTEC).				
ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 60% of the total score. The end of the Semester Examination will make up for the remaining 40% of the total score.						

RESEARCH METHODOLOGY IN RENEWABLE ENERGY

PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY		
COURSE TITLE: Research Methodology in Renewable Energy	Course Code: RET 213	Contact Hours: 2
	Credit Unit: 2	Theoretical: 1
Year: II Semester: I	Pre-requisite:	Practical: 1 Hour/week
GOAL: This course is designed to acquaint the students with the knowledge and skills on Research Methodology in Renewable Energy		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the Basic Concepts of Research Methodology. 2.0 Understand the concept of Engineering Research. 3.0 Understand Literature search and review 4.0 Understand the basic concepts of data collection 5.0 Know report preparation and presentation 6.0 Understand research and publication ethics		

PROGRAMME: **NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY**						
COURSE TITLE: RESEARCH METHODOLOGY IN RE		**COURSE CODE**: RET 213		Contact Hours: 2		
		Credit Unit: 2		Theoretical: 1		
Year: II Semester: I		Pre-requisite:		Practical: 1		
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to acquaint the students with the knowledge and skills on Research Methodology in Renewable Energy						
GENERAL OBJECTIVE 1.0: Understand the Basic Concepts of Research Methodology						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-2	1.1 Define Research 1.2 Describe research objectives 1.3 Describe research motivation. 1.4 Explain the following research approach; a) Descriptive Research vs. Analytical Research b) Applied Research vs. Fundamental Research c) Quantitative vs. Qualitative	Explain Research Explain research objectives Explain research motivation. Explain the following research approach; • Descriptive Research vs. Analytical Research • Applied Research vs. Fundamental Research • Quantitative vs. Qualitative	Textbooks, Lecture notes, Journals Marker Marker Board PC Projector Internet			

	d) Conceptual vs. Experimental (or Empirical) e) Research Methodology versus Research Methods 1.5 Explain the significance of research 1.6 Describe the research process 1.7 Explain the concept of basic and applied research processes 1.8 Explain the criteria for good research.	• Conceptual vs. Experimental (or Empirical) • Research Methodology versus Research Methods Explain the significance of research Discuss the research process Discuss the concept of basic and applied research processes Explain the criteria for good research.				
General Objective 2.0: Understand the concept of Engineering Research						
3-4	2.1 Define engineering research. 2.2 Explain the importance of research in engineering context. 2.3 Explain engineering research process	Explain engineering research. Explain the importance of research in engineering research. Explain engineering research process	Textbooks, Lecture notes, Journals Marker Marker Board PC Projector Internet			

	2.4 Describe the following: • Research Question • Hypothesis • Measuring Variables • Sampling 2.5 Explain framing of research questions as applied to engineering 2.6 Explain the characteristics of good engineering research questions 2.7 Explain the following: • Research Formulation • Literature Review • Problem Definition • Problem Formulation 2.8 Explain the following research methods: • Multi-Methods • Mixed-Methods • Multi-Modal 2.9 Describe conclusive proof in engineering research.	Explain the following: • Research Question • Hypothesis • Measuring Variables • Sampling Explain framing of research questions as applied to engineering Explain the characteristics of good engineering research questions Explain the following: • Research Formulation • Literature Review • Problem Definition • Problem Formulation Explain the following research methods: • Multi-Methods • Mixed-Methods • Multi-Modal				

		Discuss conclusive proof in engineering research.				
General Objective 3.0: Understand Literature search and review						
5-7	3.1 Describe archival literature 3.2 Explain literature search 3.3 Explain Literature Review Process 3.4 Describe the concept of Literature review 3.5 Explain Literature Review Process 3.6 Explain types of Review Articles 3.7 Explain types of publications 3.8 Describe the measure of research impact	Explain archival literature Explain literature search Explain Literature Review Process Describe the concept of Literature review Explain Literature Review Process Explain types of Review Articles Explain types of publications Describe the measure of research impact	Textbooks Lecture notes Journals Marker Marker Board PC Projector Internet			
General Objective 4.0: Understand the basic concepts of data collection						
8-9	4.1 Define data collection 4.2 Describe the following:	Explain data collection Describe the following: • Primary and secondary data	Textbooks Lecture notes Journals Marker Marker Board			

	• Primary and secondary data • Primary and secondary data sources 4.3 Explain different data Collection methods 4.4 Explain data processing 4.5 Describe different classifications of data. 4.6 Describe the following data analysis methods a. Statistical analysis b. Multivariate analysis c. Correlation analysis d. Regression analysis 4.7 Explain data Sampling	• Primary and secondary data sources Explain different data Collection methods Explain data processing Describe different classifications of data. Discuss the following data analysis methods • Statistical analysis • Multivariate analysis • Correlation analysis • Regression analysis Explain data Sampling	PC Projector Internet			
General Objective 5.0: Know report preparation and presentation						
10-13	5.1 Explain the concept of report preparation 5.2 Describe the report structure 5.3 Explain types of reports	Explain the concept of report preparation Explain the report structure Explain types of reports	Textbooks, Lecture notes, Journals Marker Marker Board PC Projector Internet	Explore different aspects of report preparation and presentation by • Reading published information. • Carrying out the experiment.	Guide students to: Explore different aspects of report preparation and presentation by • Reading published information.	Laboratory Manuals Engineering Journals

	5.4 Explain different types of report presentation 5.5 Describe the elements of presentation 5.6 Explain report presentation guidelines: • PowerPoint presentation • Practical Manual • Project	Explain different types of report presentation Discuss the elements of presentation Explain report presentation guidelines		• Collect and organize data from the experiment and the published information. • Interpret the results • Communicate findings by writing laboratory practical reports Prepare a practical report that outlines the required sections of the report: • Abstract • Introduction • Materials and methods • Results • Discussion • Conclusion • References.	• Carrying out the experiment. • Collect and organize data from the experiment and the published information. • Interpret the results • Communicate findings by writing laboratory practical reports Prepare a practical report that outlines the required sections of the report: • Abstract • Introduction • Materials and methods • Results • Discussion • Conclusion • References.	

General Objective 6.0: Understand research and publication ethics						
14-15	6.1 Explain the concept of publication ethics 6.2 Describe the following: • Law of Patents • Patent Searches • Ownership • Patentability and Patent transfer • Patent Infringement 6.3 Explain Ethics in scientific research 6.4 Explain publication ethics 6.5 Explain plagiarism 6.6 List plagiarism Software tools 6.7 Describe open access initiatives 6.8 Explain the following: • Databases • Research metrics	Explain the concept of publication ethics Describe the following: • Law of Patents • Patent Searches • Ownership • Patentability and Patent transfer • Patent Infringement Explain Ethics in scientific research Explain publication ethics Explain plagiarism List plagiarism Software tools Discuss open access initiatives Explain the following: • Databases • Research metrics	Textbooks, Lecture notes, Journals Marker Marker Board PC Projector Internet			

ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 60% of the total score. The end of the Semester Examination will make up for the remaining 40% of the total score.

INTRODUCTION TO RENEWABLE ENERGY APPLICATION PACKAGES

PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY		
COURSE TITLE: INTRODUCTION TO RENEWABLE ENERGY APPLICATION PACKAGES	Course Code: RET 214 Credit Unit: 2	Contact Hours: 2 Theoretical: 1
Year: II Semester: I	Pre-requisite:	Practical: 1 Hour/week
GOAL: This course is designed to acquaint the students with knowledge and skills of soft computing in Renewable Energy		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Know renewable energy application packages 2.0 Know the renewable energy applications packages 3.0 Know basic concept of Soft Computing in Renewable Energy		

PROGRAMME: **NATIONAL DIPLOMA IN RENEWARBLE ENERGY TECHNOLOGY**						
COURSE TITLE: INTRODUCTION TO RENEWABLE ENERGY APPLICATION PACKAGES		**COURSE CODE**: RET 214		Contact Hours: 2		
		Credit Unit: 2		Theoretical: 1		
Year: II Semester: I		Pre-requisite:		Practical: 1		
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to acquaint students with knowledge and skills of soft computing in Renewable Energy						
GENERAL OBJECTIVE 1.0: Know Renewable Energy application packages						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-5	1.1 Explain the concept of software Application in RE 1.2 Explain types of Software Application in RE 1.3 Explain areas of use of energy software application in RE	Explain the concept of software Application in RE Explain types of Software Application in RE Explain areas of use of energy soft application in RE	Textbook Journal PC Projector Marker Markerboard Internet	Identify the software application system in RE	Guide the students to: Identify the software application system in RE	RE Software application
General Objective 2.0: **Know the renewable energy applications packages**						
6-10	2.1 Define application packages	Explain application packages	Textbook Journal PC Projector	Install the following RE application packages • RETScreen	Guide students to: Install the following RE application	RETScreen System Advisor

	2.2 Explain the following RE application packages: • Hybrid Optimization of Multiple Energy Resource (HOMER) • PV syst • RETScreen • System Advisor Model (SAM) • WindPro • Energy Plus • OpenDSS • AspenHysys • Model for Analysis of Energy Demand 2.3 Explain the installation of different RE application packages	Explain the following RE application packages: • Hybrid Optimization of Multiple Energy Resource (HOMER) • PV syst • RETScreen • System Advisor Model (SAM) • WindPro • Energy Plus • OpenDSS • Model for Analysis of Energy Demand • AspenHysys Discuss the installation of different RE application packages	Marker Markerboard Internet	• System Advisor Model (SAM) • Energy Plus • OpenDSS Assess Solar installation site using RETScreen	packages • RETScreen • System Advisor Model (SAM) • Energy Plus • OpenDSS • Model for Analysis of Energy Demand Assess Solar installation site using RETScreen	Model (SAM) Energy Plus OpenDSS Model for Analysis of Energy Demand
General Objective 3.0: **Know basic concept of Soft Computing in Renewable Energy**						
11-15	3.1 Define Soft Computing 3.2 Define Artificial Intelligence (AI)	Explain Soft Computing Explain Artificial Intelligence (AI)	Textbook Journal PC Projector Marker Markerboard	Forecast Solar Power using Microsoft excel	Guide students to: Forecast Solar Power using Microsoft excel	Microsoft Application package

	3.3 Explain soft computing techniques: • Fuzzy Logic • Neural Networks • Hybrid Models 3.4 Explain the use of Soft computing in RE system. 3.5 State the key areas of Soft computing in RE system: • Renewable energy forecasting • Optimization and control • Fault detection and diagnostics • Power quality analysis • Smart Grid management, etc. 3.6 Explain the benefits of soft computing in RE • Improved accuracy • Increase efficiency • Robustness • Reduced cost 3.7 Explain projects base learning.	Explain soft computing techniques: • Fuzzy Logic • Neural Networks • Hybrid Models Explain the use of Soft computing in RE system. Discuss the key areas of Soft computing in RE system: • Renewable energy forecasting • Optimization and control • Fault detection and diagnostics • Power quality analysis • Smart Grid management, etc. Explain the benefits of soft computing in RE • Improved accuracy • Increase efficiency • Robustness • Reduced cost	Internet			

		Explain projects base learning.				
ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 40% of the total score. The end of the Semester Examination will make up for the remaining 60% of the total score.						

RENEWABLE ENERGY INSTALLATION AND MAINTENANCE II

PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY		
COURSE TITLE: RENEWABLE ENERGY INSTALLATION AND MAINTENANCE II	Course Code: RET 221	Contact Hours:
	Credit Unit: 3	Theoretical: 1
Year: II Semester: II	Pre-requisite:	Practical: 2Hour/week
GOAL: This course is designed to equip the students with knowledge and skills to install and Maintain Renewable Energy System.		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Know Installation in renewable energy technologies 2.0 Understand the Electrical Fundamentals 3.0 Know the Installation Procedures in Solar Photovoltaic (PV) Systems 4.0 Know the Installation Procedures in Solar Thermal Systems 5.0 Know the Installation Procedures in Wind Energy Systems 6.0 Know the Installation Procedures in Hydropower Systems: 7.0 Know the Installation Procedures in Biomass Energy Systems 8.0 Know RE Systems Troubleshooting 9.0 Know Preventive Maintenance Strategies		

PROGRAMME: **NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY**						
COURSE TITLE: RENEWABLE ENERGY INSTALLATION AND MAINTENACE II		**COURSE CODE**: RET 221		Contact Hours: 3		
		Credit Unit: 3		Theoretical: 1		
Year: II Semester: II		Pre-requisite:		Practical: 2		
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip the students with knowledge and skills to install and Maintain Renewable Energy System.						
GENERAL OBJECTIVE 1.0: Understand Installation of renewable energy System						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-2	1.1 Explain renewable energy technologies 1.2 Explain installation procedures for a simple RE System 1.3 Outline Regulations and Standards 1.4 Describe practical skills in RE	Discuss renewable energy technologies Discuss installation procedures for a simple RE System Explain Regulations and Standards Explain practical skills in RE	Textbooks, lectures note, Journal PC Projector Marker Markerboard internet	Demonstrate installation layout Simulate Installation of a simple Renewable Energy system	Guide students to: Demonstrate installation layout Simulate Installation of a simple Renewable Energy system	Process flow-chart Simulation software PC system Internet
General Objective 2.0: Understand the Electrical Fundamentals						
3-4	2.1 List Renewable Energy Sources 2.2 List Electrical Components and Systems:	Explain Renewable Energy Sources and Electricity Generation	Textbooks, lectures note, Journal PC Projector	Install a simple RE Electrical system Apply relevant safety standards and regulation	Guide students to: Install a simple RE Electrical system Apply relevant	IEE Regulations

	• Inverters • Batteries • Charge controllers • Grid integration 2.3 Explain Electrical concepts • AC and DC electricity, voltage, current, and power. • Basic electrical circuits (series and parallel). • Electrical components (wires, fuses, breakers, etc 2.4 State Safety Practices: • Working at heights, electrical safety, and emergency procedures. • Personal protective equipment (PPE) requirements. • Material handling and storage.	Explain Electrical Components and Systems: • Inverters • Batteries • Charge controllers • Grid integration Explain Electrical concepts • AC and DC electricity, voltage, current, and power. • Basic electrical circuits (series and parallel). • Understanding electrical components (wires, fuses, breakers, etc. Explain Safety Practices: • Working at heights, electrical safety, and emergency procedures. • Personal protective	Marker Markerboard internet		safety standards and regulation	

		equipment (PPE) requirements. • Material handling and storage.				
General Objective 3.0: Know the Installation Procedures in Solar Photovoltaic (PV) Systems						
5-6	3.1 Explain the steps in Solar Photovoltaic (PV) Systems installation 3.2 Describe Planning for: • Designing the PV System • Assessing Solar Potential • PV Sizing • Permits and Approvals 3.3 Describe the installation techniques for: • Panels mounting • Wiring • Charge controller • Inverter • Battery storage • Protective devices • Meter connection • Grid connection	Explain the steps in Solar Photovoltaic (PV) Systems installation Explain Planning for: • Designing the PV System • Assessing Solar Potential • PV Sizing • Permits and Approvals Explain the installation techniques for: • Panels mounting • Wiring • Charge controller • Inverter • Battery storage • Protective devices • Meter connection • Grid connection	Textbooks, lectures note, Journal PC Projector Marker Markerboard internet	Demonstrate the installation techniques for: • Panels mounting • Wiring • Charge controller • Inverter • Battery storage • Protective devices • Meter connection • Grid connection Install and maintain PV systems Demonstrate PV System components sizing Demonstrate safety practices in PV System Installation	Guide students to: Demonstrate the installation techniques for: • Panels mounting • Wiring • Charge controller • Inverter • Battery storage • Protective devices • Meter connection • Grid connection Install and maintain PV systems	Tool kits, Solar Panel, Charge controller, Inverter, Battery DC/AC breakers, Meter

	3.4 Explain System Testing, Commissioning and Performance Evaluation 3.5 Explain maintenance and troubleshooting: • Regular cleaning • Visual inspection • Monitoring system performance • Inverter maintenance • Wiring and ElectricalConnections • Battery Maintenance • Professional Inspections	Explain System Testing, Commissioning and Performance Evaluation Explain maintenance and troubleshooting: • Regular cleaning • Visual inspection • Monitoring system performance • Inverter maintenance • Wiring and ElectricalConnections • Battery Maintenance • ProfessionallInspections			Demonstrate PV System components sizing Demonstrate safety practices in PV System Installation	
General Objective 4.0: Know the Installation Procedures in Solar Thermal Systems						
7-9	4.1 Define Solar Thermal System 4.2 List the components of solar thermal system: • Solar thermal collectors • Heat Transfer Fluid • Heat exchangers	Explain Solar Thermal System Explain the components of solar thermal system: • Solar thermal collectors • Heat Transfer Fluid	Textbooks, lectures note, Journal PC Projector Marker Markerboard	Identify the following: • Measuring tape • Inspection tools • Electrical system evaluation tools	Guide students to: Identify the following: • Measuring tape • Inspection tools	Measuring tape Inspection tools Electrical system evaluation tools

	• Storage tanks • Control Units • Grid connector 4.3 Explain the Solar Thermal installation procedure: ➢ Planning and preparations • Roof Assessment • Orientation and angles • System sizing • Component selection • Permit and regulation ➢ Mounting the collectors • Roof mounting • ground mounting(sturdy foundation ,clearance) ➢ Connecting the system • Piping (heat transfer fluid, insulation,) • Storage tank(location, insulation)	• Heat exchangers • Storage tanks • Control Units • Grid connector Explain the Solar Thermal installation procedure: ➢ Planning and preparations • roof Assessment • orientation and angles • system sizing • component selection • permit and regulation ➢ Mounting the collectors • roof mounting • ground mounting(sturdy foundation ,clearance)		• Safety equipment • Piping tools • Roofing tools • Welding equipment Demonstrate the installation techniques for: • Solar thermal collectors • Heat Transfer Fluid • Heat exchangers • Storage tanks • Control Units • Grid connector Install and maintain solar thermal systems	• Electrical system evaluation tools • Safety equipment • Piping tools • Roofing tools • Welding equipment Demonstrate the installation techniques for: • Solar thermal collectors • Heat Transfer Fluid • Heat exchangers • Storage tanks • Control Units • Grid connector	Safety equipment Piping tools Roofing tools Welding equipment

	• pump and control(circulation, control) 4.4 Describe safety measures: • Pressure release valve(PRV) • Thermostatic Mixing Valve (TMV) • Expansion vessel • Sensor wires 4.5 Explain testing and commissioning • Leak testing • system start up • performance monitoring 4.6 Explain the importance of following: • Measuring tape • Inspection tools • Electrical system evaluation tools • Safety equipment • Piping tools • Roofing tools • Welding equipment	➢ Connecting the system • Piping (heat transfer fluid, insulation,) • Storage tank(location, insulation) • pump and control(circulation, control) Explain safety measures: • Pressure release valve(PRV) • Thermostatic Mixing Valve (TMV) • Expansion vessel • Sensor wires Explain testing and commissioning • Leak testing • system start up • performance monitoring		Demonstrate solar thermal System components sizing Demonstrate safety practices in solar thermal System Installation	Install and maintain solar thermal systems Demonstrate solar thermal System components sizing Demonstrate safety practices in solar thermal System Installation	

		Explain the importance of following: • Measuring tape • Inspection tools • Electrical system evaluation tools • Safety equipment • Piping tools • Roofing tools • Welding equipment				
General Objective 5.0: Understand the Installation Procedures in Wind Energy Systems						
10	5.1 Explain the steps in wind energy system installation 5.2 List the components of wind turbine system: • Rotor (blades, Hub, • Nacelle • Tower • Generator • Gear box • Control system 5.3 Explain the following installation procedure in wind energy system: • Site assessment • Component identification	Explain the steps in wind energy system installation Explain the components of wind turbine system: • Rotor (blades, Hub, • Nacelle • Tower • Generator • Gear box • Control system Explain the following installation procedure in wind energy system: • Site assessment	Textbooks, lectures note, Journal PC Projector Marker Markerboard internet	Identify the components of wind turbine system: • Rotor • Nacelle • Tower • Generator • Gear box • Control system Demonstrate wind turbine mounting and connection procedure	Demonstrate the components of wind turbine system: • rotor (blades, Hub, • nacelle(the generator, gearbox, and control systems) • tower • generator • gear box • control system Demonstrate installation process	Rotor Nacelle Tower Generator Gear box Control system

	• Site planning and preparation • Foundation installation • Tower erection • Components assembly • Wiring and connection • Testing and commissioning 5.4 Explain the following troubleshooting procedure: • Common problems identification • Problem rectification • Safety procedures 5.5 Explain the following maintenance types: • Preventive • Corrective	• Component identification • Site planning and preparation • Foundation installation • Tower erection • Components assembly • Wiring and connection • Testing and commissioning Explain the following troubleshooting procedure: • Common problems identification • Problem rectification • Safety procedures Explain the following maintenance types: • Preventive • Corrective			in wind energy system installation • site assessment • component identification • site planning and preparation • foundation installation • tower erection • components assembly • wiring and connection • testing and commissioning troubleshooting • identify common problems • troubleshooting techniques	

					• safety procedures 5.5 maintenance • preventive maintenance • corrective maintenance • safety procedures	
General Objective 6.0: Know the Installation Procedures in Hydropower Systems						
11-12	6.1 Explain hydropower energy system 6.2 Explain civil work 6.3 Explain penstock installation 6.4 Explain valve installation 6.5 Explain power house construction 6.6 Explain hydro turbine, hydro-generator or turbine generator group installation 6.7 Explain drive system installation	Explain hydropower energy system Explain civil work Explain penstock installation Explain valve installation Explain power house construction Explain hydro turbine, hydro-generator or turbine generator group installation	Textbooks, lectures note, Journal PC Projector Marker Markerboard internet	Simulate the installation of hydropower energy system	Guide student to: Simulate the installation of hydropower energy system	Video clips Relevant Software

	6.8 Describe wiring, switch gear and protection installation 6.9 Explain controls and auxiliary installations 6.10 Explain testing and commissioning	Explain drive system installation Describe wiring, switch gear and protection installation Explain controls and auxiliary installations Explain testing and commissioning				
General Objective 7.0: know the Installation Procedures in Biomass Energy Systems						
13	7.1 Explain biomass energy system 7.2 List the components of Biomass system: • Combustion chamber • Boiler • steam • Electricity generator • Biodigester • Trans-esterification reactor • Fermenter 7.3 Explain Installation and Connection of: • Boiler • Conveying System	Explain biomass energy system List the components of Biomass system: • Combustion chamber • Boiler • steam • Electricity generator • Biodigester • Trans-esterification reactor • Fermenter Explain Installation and Connection of:	Textbooks, lectures note, Journal PC Projector Marker Markerboard internet	Simulate the installation of Biomass energy system	Guide student to: Simulate the installation of Biomass energy system	Video clips

	• Ash Removal System • Ventilation System • Safety System . 7.4 Explain Commissioning of biomass system: • Pre-Commissioning • Commissioning • Training	• Boiler • Conveying System • Ash Removal System • Ventilation System • Safety System . Explain Commissioning of biomass system: • Pre-Commissioning • Commissioning • Training				
General Objective 8.0 Know RE Systems Troubleshooting						
14	4.1 Explain common RE Problems and Faults. 4.2 Explain Root Cause Analysis (RCA) for RE Issues. 4.3 Explain circuit RE Analysis and Testing. 4.4 Explain RE repair and replacement Techniques. 4.5 Explain case Studies on RE System Failures.	Explain common RE Problems and Faults. Explain Root Cause Analysis (RCA) for RE Issues. Explain circuit Analysis and Testing. Explain repair and replacement Techniques. Discuss case Studies on RE System Failures.	Textbooks, lectures note, Journal PC Projector Marker Markerboard internet	Troubleshoot simple faults in RE system	Guide students to Troubleshoot simple faults in RE system	Multimeter Tool kits

General Objective 9.0 Know Preventive Maintenance Strategies						
15	1.1 Explain planning and scheduling of preventive maintenance of RE system 1.2 Explain predictive maintenance implementation techniques. 1.3 Explain asset management and life cycle planning. 1.4 Explain energy management in RE systems. 1.5 Explain the improvements in maintenance practices.	Explain planning and scheduling of preventive maintenance of RE system Explain predictive maintenance implementation techniques. Explain asset management and life cycle planning. Explain energy management in RE systems. Explain the improvements in maintenance practices.	Marker board, Marker, Textbook, Lecture note			
ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 60% of the total score. The end of the Semester Examination will make up for the remaining 40% of the total score.						

RENEWABLE ENERGY TECHNOLOGY AND APPLICATION II

PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY		
COURSE TITLE: RENEWABLE ENERGY TECHNOLOGY AND APPLICATION II	Course Code: RET: 222	Contact Hours: 3
	Credit Unit: 3	Theoretical: 1
Year: II Semester: II	Pre-requisite:	Practical: 2Hour/week
GOAL: This course is designed to acquaint students with the knowledge and skills of Renewable Energy technology and applications		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Know Solar Photovoltaic Technology 2.0 Know Solar Thermal Technology 3.0 Know Wind Energy Technology 4.0 Understand Micro Hydro Power Technology 5.0 Know Bio-energy Technology 6.0 Know Renewable Energy Hybrid Technology		

PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY						
COURSE TITLE: RENEWABLE ENERGY TECHNOLOGY AND APPLICATION II		Course Code: RET: 222		Contact Hours: 3		
		Credit Unit: 3		Theoretical: 1		
Year: II Semester: II		Pre-requisite:		Practical: 2Hour/week		
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to acquaint students with the knowledge and skills of Renewable Energy technology and applications						
GENERAL OBJECTIVE 1.0: Know Solar Photovoltaic Technology						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-2	1.1 Explain the following Solar Photovoltaic systems: • Grid connected • Off-grid • Stand-alone 1.2 Explain the merits and demerits of PV cells 1.3 Explain the operation of the solar PV system 1.4 Explain the following PV system rating terms: • Standard Test Conditions (STC)	Explain the following Solar Photovoltaic systems: • Grid connected • Off-grid • Stand-alone Explain the merits and demerits of PV cells Explain the operation of the solar PV system Explain the following PV system rating terms: • Standard Test Conditions (STC)	Textbooks, lectures note, Journal PC Projector Marker Markerboard internet	Connect Solar PV Batteries in series and Parallel Install the roof top solar PV system	Guide students to: Connect Solar PV Batteries in series and Parallel Install the roof top solar PV system	Batteries Solar RE system Ladder

	• The PVUSA Test Conditions (PTC) • California Energy Commission (CEC), • Actual Simulations (AC) 1.5 Explain types of solar Panels 1.6 Explain the following for PV storage battery: • Types • Methods of selection • Rating 1.7 Explain the selection of Solar Photovoltaic systems 1.8 Explain the installation and commissioning of the following: • Solar Roof Top systems, • Stand-alone Street light. 1.9 Describe maintenance of the Solar PV System	• The PVUSA Test Conditions (PTC) • California Energy Commission (CEC), • Actual Simulations (AC) Explain types of solar Panels Explain the following for PV storage battery: • Types • Methods of selection Explain the selection of Solar Photovoltaic systems Explain the installation and commissioning of the following: • Solar Roof Top systems, • Stand-alone Street light. Explain maintenance of the Solar PV System				
General Objective 2.0: Know Solar Thermal Technology						

3-5	2.1 Explain the concept of solar thermal technology 2.2 Explain solar thermal system classification 2.3 Explain Concentrated Solar Power (CSP) system. 2.4 Describe the following collectors: • Flat plate • Parabolic • Parabolic dish • Solar tower 2.5 Define solar dryer 2.6 Explain the Classification, construction, working of solar dryers 2.7 Outline the applications for commercial system, agro-products and domestic system.	Explain the concept of solar thermal technology Explain solar thermal system classification Explain Concentrated Solar Power (CSP) system. Discuss the following collectors: • Flat plate • Parabolic • Parabolic dish • Solar tower Explain solar dryer Explain the Classification, construction, working of solar dryers Outline the applications for commercial system, agro-products and domestic system.	Textbooks, lectures note, Journal PC Projector Marker Markerboard internet	Identify the following collectors: • Flat plate • Parabolic • Parabolic dish • Solar tower Identify different solar dryers.	Guide students to: Identify the following collectors: • Flat plate • Parabolic • Parabolic dish • Solar tower Identify different solar dryers.	Solar dryer Demonstration videos

General Objective 3.0: Know Wind Energy Technology						
6-7	3.1 Explain the concept of wind energy technology. 3.2 Explain the following types of wind energy systems: • Large and small • Commercial and domestic • Grid connected and stand-alone. 3.3 Explain the construction, operation principle and specifications Small Wind power plant 3.4 Describe the components of the small wind power plant 3.5 Explain the construction, working and specifications of large wind power plant 3.6 Describe the components of the large wind power plant	Explain the concept of wind energy technology. Explain the following types of wind energy systems: • Large and small • Commercial and domestic • Grid connected and stand-alone. Explain the construction, operation principle and specifications Small Wind power plant Explain the components of the small wind power plant Explain the construction, working and specifications of large wind power plant	Textbooks, lectures note, Journal PC Projector Marker Markerboard internet	Identify the components of the Small wind power plant Identify the components of the large wind power plant	Guide students to: Identify the components of the Small wind power plant Identify the components of the large wind power plant	Demonstration videos

	3.7 Describe the procedure to undertake routine maintenance of small wind turbines. 3.8 Describe the procedure to maintain large wind turbines.	Explain the components of the large wind power plant Discuss the procedure to undertake routine maintenance of small wind turbines. Discuss the procedure to maintain large wind turbines.				
General Objective 4.0:Understand Micro Hydro Power Technology						
8-10	4.1 Explain the concept of micro hydro power technology. 4.2 Explain the construction and working of specified type of micro hydro power systems. 4.3 List the various components in a given micro hydro power plant 4.4 Explain the selection of micro-hydro systems.	Explain the concept of micro hydro power technology. Explain the construction and working of specified type of micro hydro power systems. Explain the various components in a given micro hydro power plant	Textbooks, lectures note, Journal PC Projector Marker Markerboard internet			

	4.5 Explain the installation procedure of micro hydro power system 4.6 Describe maintenance procedure of a given type of Micro power system.	Explain the selection of micro-hydro systems. Explain the installation procedure of micro hydro power system Discuss the maintenance procedure of a given type of Micro power system.				
General Objective 5.0: Know Bio-energy Technology						
11-13	5.1 Explain the classification of biofuels. 5.2 Explain technologies for the following power plants: • Biomass • Bio-gas plants • Bio-diesel 5.3 Explain the following in relation to small power plant: • Layout • Construction • Mode of operation	Explain the classification of biofuels. Explain technologies for the following power plants: • Biomass • Bio-gas plants • Bio-diesel Explain the following in relation to small power plant: • Layout • Construction • Mode of operation	Textbooks, lectures note, Journal PC Projector Marker Markerboard internet	Identify the components of a biomass power plant	Guide students to Identify the components of a biomass power plant	Demonstration videos chart

	5.4 List the various components of a typical biomass power system. 5.5 Describe the procedure of installation of a Biogas plants. 5.6 Describe the maintenance procedure of a biomass power plant 5.7 Explain the application of various bio-fuels in the following areas: • Domestic - heating, cooking • Commercial - process heating and power generation 5.8 Explain the installation and maintenance procedure for Biogas plant.	Explain the various components of a typical biomass power system. Discuss the procedure of installation of a Biogas plants. Discuss the maintenance procedure of a biomass power plant Explain the application of various bio-fuels in the following areas: • Domestic - heating, cooking • Commercial - process heating and power generation Discuss the installation and maintenance procedure for Biogas plant.				
General Objective 6.0: Know Renewable Energy Hybrid Technology						

14-15	6.1 Explain the concept of hybrid renewable energy technology 6.2 Explain the construction and specification of following hybrid systems: • Wind-Solar • Wind-Hydro • Wind-Biogas • Solar-Biogas 6.3 Explain power output of hybrid system. 6.4 Explain how to prepare layouts of hybrid power system. 6.5 Explain the operating procedure of wind-solar PV hybrid system. 6.6 Outline the applications of wind-solar PV hybrid system. 6.7 Describe the performance parameters of Wind-Solar PV hybrid system.	Explain the concept of hybrid renewable energy technology Explain the construction and specification of following hybrid systems: • Wind-Solar • Wind-Hydro • Wind-Biogas • Solar-Biogas Explain power output of hybrid system. Explain how to prepare layouts of hybrid power system. Explain the operating procedure of wind-solar PV hybrid system. Outline the applications of wind-solar PV hybrid system.	Textbooks, lectures note, Journal PC Projector Marker Markerboard internet	Identify the following hybrid power plants: • Wind- Solar • Wind-Hydro • Wind-Biogas • Solar-Biogas	Guide students to: Identify the following hybrid power plants: • Wind- Solar • Wind-Hydro • Wind-Biogas • Solar-Biogas	Video clips

	6.8 Describe the procedure to test the performance of wind-solar PV hybrid system. 6.9 Explain the installation-procedure for wind-solar PV hybrid system 6.10 Explain the Trends in hybrid renewable energy	Discuss the performance parameters of Wind-Solar PV hybrid system. Discuss the procedure to test the performance of wind-solar PV hybrid system. Explain the installation-procedure for wind-solar PV hybrid system Explain the Trends in hybrid renewable energy				
ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 60% of the total score. The end of the Semester Examination will make up for the remaining 40% of the total score.						

EMERGING TECHNOLOGIES IN RENEWABLE ENERGY

PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY		
COURSE TITLE: EMERGING TECHNOLOGIES IN RENEWABLE ENERGY	Course Code: RET 223	Contact Hours:
	Credit Unit: 2	Theoretical: 2
Year: II Semester: II	Pre-requisite:	Practical: Nil
GOAL: This course is designed to acquaint the student with the knowledge of emerging technologies in RE		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the Basic Concept of Emerging Renewable Energy Technologies 2.0 Understand Emerging PV Technologies 3.0 Understand Emerging Wind Power Technologies 4.0 Understand Smart Grid and Grid Integration 5.0 Understand Emerging Renewable Energy Technologies in Transport		

PROGRAMME: **NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY**					
COURSE TITLE: EMERGING TECHNOLOGIES IN RENEWABLE ENERGY		Course Code: RET 223		Contact Hours:	
		Credit Unit: 2		Theoretical: 2	
Year: II Semester: II		Pre-requisite:		Practical: Nil	
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL					
GOAL: This course is designed to acquaint the student with the knowledge of emerging technologies in RE					
GENERAL OBJECTIVE 1.0: Understand the Basic Concept of Emerging Renewable Energy Technologies					
THEORETICAL CONTENT				PRACTICAL CONTENT	
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Explain Renewable and non-renewable energy sources 1.2 Explain the role of emerging technologies in renewable energy 1.3 Explain the potential impacts of emerging renewable energy technologies 1.4 Explain renewable energy for future generations 1.5 Explain the following emerging technologies • Floating Solar Farms	Explain Renewable and non-renewable energy sources Explain the role of emerging technologies in renewable energy Explain the potential impacts of emerging renewable energy technologies Explain renewable energy for future generations Explain the following emerging technologies • Floating Solar Farms	Textbooks, lectures note, Journal PC Projector Marker Markerboard internet			

	• Green Hydrogen • Energy-Generating Roads • Advanced Energy Storage • Airborne Wind Energy (AWE) • Artificial Photosynthesis • Enhanced Geothermal Systems (EGS) • Green Buildings	• Green Hydrogen • Energy-Generating Roads • Advanced Energy Storage • Airborne Wind Energy (AWE) • Artificial Photosynthesis • Enhanced Geothermal Systems (EGS) • Green Buildings				
General Objective 2.0: Understand Emerging PV Technologies						
4-5	2.1 Explain the basic concept of emerging PV technologies 2.2 Explain the following Photovoltaic Solar Cells technologies: • Multi-Junction Cells • Tandem Cells • Perovskite-Silicon 2.3 Explain concentrated solar power (CSP) 2.4 Explain the following technologies:	Explain the basic concept of emerging PV technologies Explain the following Photovoltaic Solar Cells technologies: • Multi-Junction Cells • Tandem Cells • Perovskite-Silicon Explain concentrated solar power (CSP)	Textbooks, lectures note, Journal PC Projector Marker Markerboard internet			

	• Organic PVs (OPVs) • Quantum dot • Solar film • Solar paint • Solar glass • Solar Skin	Explain the following technologies: • Organic PVs (OPVs) • Quantum dot • Solar film • Solar paint • Solar glass • Solar Skin				
General Objective 3.0: Understand Emerging Wind Power Technologies						
6-8	3.1 Explain the concept of emerging wind power technologies 3.2 Explain offshore Wind Turbines 3.3 Explain the floating wind farms 3.4 Explain the vertical axis wind turbines	Explain the concept of emerging wind power technologies Explain offshore Wind Turbines Explain the floating wind farms Explain the vertical axis wind turbines	Textbooks, lectures note, Journal PC Projector Marker Markerboard internet			
General Objective 4.0:Understand Emerging Energy Storage Technologies						
9-10	4.1 Explain the emerging concepts in energy storage 4.2 Explain the following emerging storage technologies: • Lithium-ion Batteries	Explain the emerging concepts in energy storage Explain the following emerging storage technologies: • Lithium-ion Batteries	Textbooks, lectures note, Journal PC Projector Marker Markerboard internet			

	• Flow Batteries 4.3 Explain the following Hydrogen Storage: • Hydrogen Fuel Cells • Hydrogen Electrolysis 4.4 Explain the following thermal storage technology: • Miscibility Gaps Alloy 4.5 Explain the compressed air energy storage 4.6 Explain the flywheel energy storage	• Flow Batteries Explain the following Hydrogen Storage: • Hydrogen Fuel Cells • Hydrogen Electrolysis Explain the following thermal storage technology: • Miscibility Gaps Alloy Explain the compressed air energy storage Explain the flywheel energy storage				
General Objective 5.0: Understand Smart Grid and Grid Integration						
11-12	5.1 Define Smart grid 5.2 Outline the functions of smart grid 5.3 Explain the traditional power grid and smart grid 5.4 Explain smart grid and distributed energy system	Explain Smart grid Explain the functions of smart grid Explain the traditional power grid and smart grid Explain smart grid and distributed energy system	Textbooks, lectures note, Journal PC Projector Marker Markerboard internet			

	5.5 Explain the following emerging technologies for smart grid • Advanced Metering Infrastructure (AMI) • Grid Sensors and Monitoring • Distribution Automation • Energy Storage • Microgrids • Grid Analytics	Explain the following emerging technologies for smart grid • Advanced Metering Infrastructure (AMI) • Grid Sensors and Monitoring • Distribution Automation • Energy Storage • Microgrids • Grid Analytics				
General Objective 6.0: Understand Emerging Renewable Energy Technologies in Transport						
13-14	6.1 Explain Electric vehicles (EV) 6.2 Explain the following electric Vehicles • Hybrid Electric Vehicles (HEV) • Plug-in Hybrid ElectricVehicles (PHEV) 6.3 Define transportation electrification	Explain Electric vehicles (EV) Explain the following electric Vehicles • Hybrid Electric Vehicles (HEV) • Plug-in Hybrid ElectricVehicles (PHEV) Explain transportation electrification	Textbooks, lectures note, Journal PC Projector Marker Markerboard internet			

	6.4 Explain the following transport electrification concepts: • Transitioning to Electric Vehicles • Expanding Charging Infrastructure • Integrating EV charging station with the Grid	Explain the following transport electrification concepts: • Transitioning to Electric Vehicles • Expanding Charging Infrastructure • Integrating EV charging station with the Grid				
ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 40% of the total score. The end of the Semester Examination will make up for the remaining 60% of the total score.						

ENGINEERING PROJECT MANAGEMENT

PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY		
COURSE TITLE: ENGINEERING PROJECT MANAGEMENT	Course Code: RET 224	Contact Hours: 2
	Credit Unit: 2	Theoretical: 2
Year: II Semester: II	Pre-requisite:	Practical:
GOAL: This course is designed to equip the student with the knowledge and skills of Renewable Energy engineering project management		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand the basic concepts of project management 2.0 Understand engineering project organization 3.0 Understand project planning and development 4.0 Understand project finance and contract management 5.0: Understand project cost estimating and tendering		

PROGRAMME: **NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY**						
COURSE TITLE: ENGINEERING PROJECT MANAGEMENT		**COURSE CODE**: RET 224		Contact Hours: 2		
		Credit Unit: 2		Theoretical: 2		
Year: II Semester: II		Pre-requisite:		Practical:		
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to equip the student with the knowledge and skills of Renewable Energy engineering project management						
GENERAL OBJECTIVE 1.0: Understand the basic concepts of project management						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-2	1.1 Define the following terms; • Project • Project management • Project manager 1.2 Explain the difference between project management and engineering management 1.3 Explain the elements of project management 1.4 Explain engineering project management methodologies	Explain the following terms; • Project • Project management • Project manager Explain the difference between project management and engineering management Explain the elements of project management Discuss engineering project management methodologies	Textbooks, Lecture notes Journals Marker Markerboard PC Projector internet			

	1.5 Explain programmes and portfolio management 1.6 Explain the challenges in engineering project management	Explain programmes and portfolio management Discuss the challenges in engineering project management				
General Objective 2.0: Understand Engineering Project Organization						
3-5	2.1 Explain the basic concepts of Project Organization 2.2 Describe the elements of a strong project organizational structure. 2.3 Explain types of project organizational structure in project management 2.4 Describe the functional project organizational structure 2.5 Explain team establishment within project organizational structure	Explain the basic concepts of Project Organization Explain the elements of a strong project organizational structure. Explain types of project organizational structure in project management Discuss the functional project organizational structure Explain team establishment within project organizational structure Discuss factors influencing project	Textbooks, Lecture notes Journals Marker Markerboard PC Projector internet			

	2.6 Describe factors influencing project organization 2.7 Explain span of control in project organization	organization Explain span of control in project organization				
General Objective 3.0: Understand Project planning and development						
6-8	11.9Explain the basic concept of project planning and development 11.10 Explain objectives of planning. 11.11 Explain components of a project plan 11.12 Describe project planning model. 11.13 Explain the importance of project development 11.14 Explain the steps to build a strong project development process	Explain the basic concept of project planning and development Explain objectives of planning. Explain components of a project plan Describe project planning model. Explain the importance of project development Explain the steps to build a strong project development process	Textbooks, Lecture notes Journals Marker Markerboard PC Projector internet			

General Objective 4.0: Know Project finance and contract management						
9-11	4.1 Define; • Project finance • Contract management 4.2 Explain types and sources of capital for engineering project financing 4.3 Explain the following: • Purchases Versus Leasing • Sales lease back versus Hire Purchase 4.4 Explain project appraisal and performance evaluation 4.5 Describe the nature of engineering contracts management 4.6 Describe stages for evaluation of engineering contracts	Explain; • Project finance • Contract management Explain types and sources of capital for engineering project financing Explain the following: • Purchases Versus Leasing • Sales lease back versus Hire Purchase Explain project appraisal and performance evaluation Discuss the nature of engineering contracts management Explain stages for evaluation of engineering contracts	Recommended text books, Lecture notes, related journals and materials and internet			

	4.7 Explain contractor financed capital projects challenges.	Explain contractor financed capital projects challenges.				
General Objective 5.0: Understand Project cost estimating and tendering						
12-14	5.1 Explain the concept of cost estimating 5.2 Explain material estimating of engineering project activities 5.3 Explain the preparation of the following bills for project cost determination: • Bill of quantities (BOQ) • Bill of engineering measurement and evaluation (BEME) 5.4 Describe the purpose of tendering 5.5 Explain tendering procedure	Explain the concept of cost estimating Explain material estimating of engineering project activities Explain preparation of the following bills for project cost determination: • Bill of quantities (BOQ) • Bill of engineering measurement and evaluation (BEME) Explain the purpose of tendering Explain tendering procedure Explain different forms of tender-bill of quantities and materials.	Text books, Lecture notes, related journals and materials and internet			

	5.6 Explain different forms of tender-bill of quantities and materials. 5.7 Explain the following: • Schedules of rates • Tender-standing offer • Simple offer • Tendering and contract formation. 5.8 Explain types of tender-standing offer 5.9 Describe tendering arrangements	Explain the following: • Schedules of rates • Tender-standing offer • Simple offer • Tendering and contract formation. Explain types of tender-standing offer Describe tendering arrangements				
ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 40% of the total score. The end of the Semester Examination will make up for the remaining 60% of the total score.						

ENGINEERING ETHICS

PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY		
COURSE TITLE: Engineering Ethics	Course Code: RET 225	Contact Hours: 2
	Credit Unit: 2	Theoretical: 2
Year: II Semester: II	Pre-requisite:	Practical: 0 Hour/week
GOAL: This course is designed to acquaint students with the knowledge of engineering professional ethics		
GENERAL OBJECTIVES: On completion of this course, the students should be able to: 1.0 Understand basic concept of Engineering Ethics 2.0 Understand principles of ethics in renewable energy 3.0 Understand the social impacts of Renewable Energy 4.0 Understand the environmental impacts of Renewable Energy 5.0 Understand Renewable Energy Professional ethics		

PROGRAMME: **NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY**						
COURSE TITLE: Engineering Ethics		**COURSE CODE**: RET 225		Contact Hours: 2		
		Credit Unit: 2		Theoretical: 2		
Year: II Semester: II		Pre-requisite:		Practical: Nil		
COURSE SPECIFICATION: THEORETICAL AND PRACTICAL						
GOAL: This course is designed to acquaint students with the knowledge of engineering professional ethics						
GENERAL OBJECTIVE 1.0: Understand basic concept of Engineering Ethics						
THEORETICAL CONTENT				PRACTICAL CONTENT		
Week	Specific Learning Outcome	Teacher's Activities	Resources	Specific Learning Outcome	Teacher's Activities	Resources
1-3	1.1 Define engineering ethics 1.2 Explain the role of technicians in society. 1.3 Explain importance of ethical decision-making.	Explain Engineering Ethics Explain the role of technicians in society. Explain the importance of ethical decision-making.	Textbooks, Lecture notes, Journals Marker Marker Board PC Projector			
General Objective 2.0: **Understand principles of ethics in renewable energy**						
5-7	2.1 Explain theories related to ethics: • Utilitarianism • Deontology • Virtue ethics	Explain theories related to ethics: • Utilitarianism • Deontology • Virtue ethics Explain the concept of justice and fairness.	Textbooks, Lecture notes, Journals Marker Marker Board PC Projector			

	2.2 Explain the concept of justice and fairness. 2.3 Explain professional codes of conduct relevant to renewable energy. 2.4 Explain concept of ethical decision-making.	Explain professional codes of conduct relevant to renewable energy. Explain concept of ethical decision-making.				
General Objective 3.0: **Understand the social impacts of Renewable Energy**						
8-10	3.1 Explain the Social impact of access to energy. 3.2 Explain the social impact of renewable energy on communities. 3.3 Explain the ethical implications of energy pricing and subsidies. 3.4 Explain safety issues in Renewable energy projects	Explain the Social impact of access to energy. Explain the social impact of renewable energy on communities. Explain the ethical implications of energy pricing and subsidies. Explain safety issues in Renewable energy projects	Textbooks, Lecture notes, Journals Marker Marker Board PC Projector			
General Objective 4.0:**Understand the environmental impacts of Renewable Energy**						
11-13	4.1 Explain ethics of resource use and depletion.	Explain ethics of resource use and	Textbooks, Lecture notes,			

	4.2 Explain the concept of environmental impact assessment and mitigation. 4.3 Explain the role of renewable energy in addressing climate change. 4.4 Explain the environmental impacts of solar, wind, and hydro projects.	depletion. Explain the concept of environmental impact assessment and mitigation. Explain the role of renewable energy in addressing climate change.	Journals Marker Marker Board PC Projector			
General Objective 5.0: **Understand the Renewable Energy Professional ethics**						
14-15	5.1 Explain technician's responsibility concerning renewable energy to the public. Explain the concepts of: • Confidentiality • Conflicts of interest • Whistleblowing.	Explain technician's responsibility concerning renewable energy to the public. Explain the concepts of: • Confidentiality • Conflicts of interest • Whistleblowing.	Textbooks, Lecture notes, Journals Marker Marker Board PC Projector			

	5.2 Explain the role of technicians in promoting sustainable practices. Enumerate ethical dilemmas in renewable energy projects.	Explain the role of technicians in promoting sustainable practices. Enumerate ethical dilemmas in renewable energy projects.				
ASSESSMENT: The continuous assessment, tests and quizzes will be awarded 40% of the total score. The end of the Semester Examination will make up for the remaining 60% of the total score.						

PRACTICAL MANUAL

RET 311 **Introduction to Renewable Energy**	1. Identify simple renewable energy devices/systems: • Solar panels • Portable windmills • Hydropower • Biomass 2. Identify: • Solar dryer • Solar cooker • Solar water heater • Solar distiller • Solar thermal power system 3. Measure solar radiation levels at different time of the day 4. Identify various types/parts of wind turbine. 5. Measure wind speed. 6. Measure wind direction. 7. Identify various components of small hydro power systems. 8. Identify the various types of biomass: • Jatropha carcass • Sugarcane

	• Maize, • Animal dung, • Human faeces, etc. 9. Identify Biomass System components: • Digesters • Cylinders • Bunners • Soxhlet extractors • Biodigesters 10. Identify various energy storage systems
RET 112 Physics of Renewable Energy Systems	1. Test solar energy 2. Plot the V-I characteristics of solar cell and determine the Fill Factor (FF) 3. Measure the effect of PV panel temperature on output power generation 4. Simulate: • Tidal energy concepts • Hydropower energy concepts • Geothermal energy concepts 5. Identify the components of the batteries above 6. Identify the following storage systems: • Capacitors • Flywheels • Pumped Hydropower • Compressed Air Energy Storage (CAES)

	• Pumped Heat Electrical Storage (PHES)
RET 113 **Basic Chemistry for Renewable Energy**	1. Identify the various sources to produce biodiesel, bioethanol and biogas 2. Demonstrate simple fermentation, transesterification and anerobic digestion processes for the conversion of biomass into biofuels 3. Identify different types of battery 4. Measure battery efficiency parameters
RET 121 RENEWABLE ENERGY AND ENVIRONMENT	1. Detect the prevalent environmental conditions in the immediate environment. 2. Visit different RE sites to have practical experience and be introduced to relevant equipment. 3. Establish the relationship and interaction between RE sources and different environments. 4. Prepare EIA and EIS for any two different projects within the campus
Introduction to Digital Electronics EEC 112	1. Demonstrate conversion from decimal and hexadecimal 2. Investigate the logical behavior of AND, OR, NOT, NAND, NOR, and EX-OR gates. 3. Show the NAND gate as a Universal Gate 4. Interpret truth tables for logic gates 5. Verify Boolean Laws using the various logic gates 6. Construct the truth table of various logic gates and combination circuits using logic gates.

	7. Evaluate various combinational circuits such as adders, subtractors, 8. Design and implement adders and subtractors using logic gates 9. Implement adders and subtractors using logic gates 10. Design and implement of 4-bit binary adder/subtractor and BCD adder using digital ICs 11. Implement of 4-bit binary adder/subtractor and BCD adder using digital ICs 12. Interpret truth tables for multiplexers and de-multiplexers 13. Implement multiplexer and demultiplexer using logic gate 14. Design multiplexer and demultiplexer using logic gates and study of IC 74150 and IC 74154 15. Evaluate flip-flops, counters, and shift registers. 16. Implement SISO, SIPO, PISO, and PIPO shift registers using flip-flops. 17. Verify of 4-bit ripple counter and Mod-10, Mod-12, and Mod-N ripple counters 18. Simulate various combinational circuits, sequential circuits flip-flops, and counters. using relevant software 19. Interpret Truth Tables for latches, flip flops, and counters

	20. Identify the Microcontrollers. 21. Identify Microcontroller Input/Output ports, power pins, reset and clock pins. 22. Perform Basic Programming. 23. Load the program from PC to microcontroller via programmer. 24. Setup the hardware (vero board, breadboard, microcontroller, led, sensors. Interface microcontrollers with sensors
RET 211 RENEWABLE ENERGY INSTALLATION AND MAINTENANCE I	1. Identify Graphical symbols in installation of RE system 2. Draft RE Symbols Using RE Software 3. Produce wiring/connection diagram for RE system 4. Draw the wiring diagram of RE system 5. Connect RE Protective Devices 6. Connect RE Appliances and Equipment 7. Carry out inspection and testing of RE installation 8. Identify RE Codes and regulations 9. Develop a simple maintenance plan for RE system 10. Demonstrate lubrication and cleaning of RE equipment. 11. Demonstrate the use of RE diagnostic tools and instruments 12. Carryout maintenance of RE Appliances and Equipment
RET 212 RENEWABLE ENERGY	1. Identify different kinds of renewable energy technologies.

TECHNOLOGY AND APPLICATION I	2. Measure solar radiation 3. Connect solar cells in series and parallel 4. Simulate concentrating solar power technologies (CSP) 5. Identify the wind Turbine 6. Identify horizontal and vertical axis machines 7. Measure wind turbine energy generation 8. Identify any biofuels plants 9. Identify the components of any of the following plants: • Biogas • Biodiesel • Bioethanol
RET 213 RESEARCH METHODOLOGY IN RE	1. Explore different aspects of report preparation and presentation by • Reading published information. • Carrying out the experiment. • Collect and organize data from the experiment and the published information. • Interpret the results

	• Communicate findings by writing laboratory practical reports 2. Prepare a practical report that outlines the required sections of the report: • Abstract • Introduction • Materials and methods • Results • Discussion • Conclusion • References.
RET 214 **INTRODUCTION TO RENEWABLE ENERGY APPLICATION PACKAGES**	1. Identify the software application system in RE 2. Install the following RE application packages • RETScreen • System Advisor Model (SAM) • Energy Plus • OpenDSS 3. Assess Solar installation site using RETScreen of rectifier outputs. 4. Forecast Solar Power using Microsoft excel
RET 221 RENEWABLE ENERGY INSTALLATION AND MAINTENANCE II	1. Demonstrate installation layout 2. Simulate Installation of a simple Renewable Energy system 3. Install a simple RE Electrical system 4. Apply relevant safety standards and regulation

	5. Demonstrate the installation techniques for: • Panels mounting • Wiring • Charge controller • Inverter • Battery storage • Protective devices • Meter connection • Grid connection 6. Install and maintain PV systems 7. Demonstrate PV System components sizing 8. Demonstrate safety practices in PV System Installation 9. Identify the following: • Measuring tape • Inspection tools • Electrical system evaluation tools • Safety equipment • Piping tools • Roofing tools • Welding equipment 10. Identify the components of wind turbine system: • Rotor • Nacelle

	• Tower • Generator • Gear box • Control system 11. Demonstrate wind turbine mounting and connection procedure 12. Simulate the installation of hydropower energy system 13. Simulate the installation of Biomass energy system 14. Troubleshoot simple faults in RE system
RET 222 RENEWABLE ENERGY TECHNOLOGY AND APPLICATION II	1. Connect Solar PV Batteries in series and Parallel 2. Install the roof top solar PV system 3. Identify the following collectors: • Flat plate • Parabolic • Parabolic dish • Solar tower 4. Identify different solar dryers. 5. Identify the components of the Small wind power

	plant 6. Identify the components of the large wind power plant 7. Identify the components of a biomass power plant 8. Identify the following hybrid power plants: • Wind- Solar • Wind-Hydro • Wind-Biogas • Solar-Biogas

LIST OF EQUIPMENT FOR NATIONAL DIPLOMA RENEWABLE ENERGY

Facilities

S/N	Workshops	Laboratories	Studios
i	Renewable Energy Workshop	Renewable Energy	Computer Studio
ii.	Machining Shop	Basic Electricity, Measurement and Instrumentation	Drawing Studio
iii.		Electronics	
iv.		Fluid Mechanics	
v		Thermodynamics	

ND Renewable Energy Workshop

	General requirements	
	DC/AC breakers	Assorted
	Faulty Solar panels Mono-crystalline Poly-crystalline Amorphous-Silicon Bi-Facial	 Assorted “ “ “
	Measuring tape	5
	Safety equipment	Assorted
	Piping tools	Assorted
	Roofing tools	Assorted
	Toolboxes Electrical Mechanical	 2 2
	Flywheels	1

	Pumped Hydropower	1
	Compressed Air Energy Storage (CAES)	1
	Pumped Heat Electrical Storage (PHES)	1
	Thermometer	Assorted
	Barometer	1
	Hygrometer	1
	Temperature probes	Assorted
	Air velocity meter	2
	Solar Irradiation Sensor	Assorted
	Batteries	Assorted
	Solar charge controllers MPPT PWM	 3 3
	Wind charge controllers	3
	Portable wind mill	1
	Laboratory Manuals	Assorted
	Flywheels	1
	Hand drilling machines	
	Angle iron (Assorted)	
	Pipes (Assorted)	
	Bolts and Nuts (Assorted)	
	Saws (Power Hacksaw, hand-held saw, etc)	3
	Hammers	20
	Metal rules	30
	Galvanized metal sheets (Assorted)	25
	Complete tool box (Electrical and Mechanical)	2 each
	Bench drilling machine	1
	Hand grinders/Pedestal grinder	5

	Bench Vice	1
	Rivet gun	2
	Plywood (Assorted)	5 each
	Personal protective equipment	-
	Aluminum ladder/Wooden ladder	1
	Cables (Assorted)	-
	Power projector	1
	Computers	2
	Pipe Vice	1
	Plumbing materials PVC (Assorted)	-
	Projector	1
	First Aid Box	1
	Computers	2
	Insert	

Machine Shop

S/N	Description of Equipment	No. Required
	Tool room lathe with swing 483 mm and bed 200 mm	1
	Centre lathe with the swing of 330 mm and length of bed 150 mm with com Plate accessories	3
	Column/pillar drilling machine	1
	Universal milling machine complete with accessories	1
	Universal engraving machine complete with accessories	1
	Surface grinding machine complete with accessories	1
	Universal cylindrical grinding machine with accessories	1
	Pedestal grinding machine	1
	Power hacksaw	1

	Arbor/hydraulic press	
	Shaping machine with accessories	1
	Universal tool and cutter grinder	1
	Box spanners	5
	Allen Keys (set)	2 sets
	Flat screw driver (set) 3 sets	2 sets
	Philips screw driver	2 sets
	Drift/pin punches (various sizes)	2 sets each
	Knurling tools	2 sets
	Parallel strips	3
	Vernier protractor	3
	Micrometers outside 0.25 mm 25-50 mm 50-75 mm and sets of Inside micrometers	3
	Depth gauge	5
	Steel rule 300 mm	5
	Calipers (inside and outside)	5
	Vee block with clamps	4
	Scribing block	4
	Surface plate	3
	Wheel dresser	2
	Hand/machine reamers (sets)	2 each
	Oil Can	2
	Centre drills (set)	2 sets
	Twists drills (set)	2 sets
	Thread chaser (Assorted) 3 each	2 each
	Marking out table	2
	Combination set	4

	Screw gauges (assorted	4
	Plug gauges (assorted)	4
	Radius gauges (assorted)	4
	Dial indicator and stand	4
	Slip gauges (set)	2
	Grease gun	2
	Angle plates	3
	Engineer's square	5
	Measuring balls/rollers	2
	Limit gauges	5
	Fire Extinguisher/Sand Buckets	2 each

Fitting Shop

S/N	Description of Equipment	No. Required
	Bench vice	20
	Pillar drilling machine	1
	Radial drilling machine	1
	Sensitive bench drilling machine	2
	Marking out table	1
	Surface plate	1
	Pedestal grinder with drill grinding attachment	1
	Power hacksaw	1
	Multi-purpose furnace	1
	Arbor press	1
	Flat rough file (300 mm) Round rough file (300 mm) Round smooth file (300 mm) Source rough file (300 mm)	5 Each

	Flat smooth file 250 mm) Half round rough file (150 mm) Triangular rough file (150 mm) Half round smooth file (250 mm) Triangular smooth file (150 mm)	
	Guillotine	2
	Try-square Dividers Steel rule Wallets of warding file 10 sets Scribers Vee block and clamp Scribing block Centre punches Cold chisels (set) Scrapers (set)	10 each
	Vernier Caliper Hacksaw frame Stock and dies (set) metric Taps and wrenches (set) metric Hand drill Centre drills Lot Tap extractor (set) Screw extractor (set)	3 sets each
	Screw gauges (assorted) Screw driver (set) and Hammers (assorted weight)	2 each
	Measuring tapes Feeler gauges Rivet gun pairs Goggles Drill set	2 each 2 4 pairs 10 pairs 4 sets

	Electric Hand drill Electric hand grinder/sander Vernier height gauge Dial indicators and stand Mallets (rubber, wood/rawhide)/Number stamps	4 2 4 4
	Letter stamps Hydraulic press Punches (cold) Plier (assorted) Hand shear Welding chipping hammer Wire brush (bench type) Welding shield	3 each 3 3 3 3 3 3
	Profile cutting machine	1
	Foot operated guillotine machine	1
	Assorted cutting snips	1
	Twist drill sets	2
	Aprons	10
	Fire Extinguisher/sand buckets	2 each

Laboratories

Renewable Energy Laboratory

S/N	Name	Quantity
	Biomass System	
	Radiation meter	5
	Biomass demonstration module or fabricated Biomass system	1
	Biomass Unit Charts	Assorted

	Biogas plant (proto-type) fixed doomed	1
	Biomaterial digester (hand-made)	assorted
	Pulverizes	1
	Biogas pyrolysis system	1
	Pyranometer	1
	Pyrgeometer	1
	Soxhlet extractor sets	1
	PV System	
	Solar panels (Monocrystalline), 12V/50W, 12V/80W, 24V/250W	10 each
	Solar panels (Polycrystalline) 12V/50W, 12V/80W, 24V/250W	10 each
	Solar panels (Amorphous) 12V/50W, 12V/80W, 24V/250W	10 each
	Digital Multimeter	20
	DC bulbs (12V/30W; 12V/35W; 24V/30W)	50 each
	DC rechargeable lamps	5
	Soldering Iron and Lead	5
	Blowers	5
	Solar Charge controllers (12V/24V 10, 20 and 30Amps)	15 each
	Solar Charge controllers (24V/48V 40, 50 and 60Amps)	15 each
	Inverters (DC/AC; sinewave, modified sinewave and square wave)	2 each
	Deep cycle batteries (Assorted)	12
	Inverters	Assorted
	AC bulbs	Assorted
	Cables	Assorted
	Solar thermal collector	1
	Hydrometer	5
	Oscilloscope (single and dual beam)	1 each
	Wattmeter	3

	Wiring board	30
	Rheostat	3
	Radiation meter	5
	Multimeter	20
	Solar cells	Assorted
	Voltage probe	5
	Current probe	5
	Light sensor	5
	K-type thermocouple	5
	1000w Tungsten halogen discharge lamp	Assorted
	Color filters	Assorted
	Capacitors	Assorted
	Insert	

	Solar Thermal System	
	Plain glasses	10
	Lenses (parabolic and converging) of different focal length	5 each
	Thermometers (digital and mercury-in-glass - assorted)	10 each
	Thermocouples (Assorted)	10
	PVC gums	10
	100 – 250 Liters plastic water tanks for solar water heater	2
	Charts	Assorted
	Wind Energy System	
	Wind turbine demonstration module or fabricated Prototype of wind turbine system	1
	Wind Energy Unit Charts	Assorted
	Prototype Vertical Axis Wind Turbine (VAWT) – instructional material	2

	Prototype of Horizontal Axis Wind Turbine (HAWT) – instructional material	2
	Wind energy charge controllers	2
	Anemometers	2
	Hygrometer	1
	Mobile weather station	1
	Small Hydro Power System	
	Prototype of small hydro power (Fabricated)	1
	Small Hydro Power System Charts	Assorted
	Dumpy level instrument with tripod stand	1
	Rectangular notch weir	2
	Water current meters	1
	2000 – 3000 liters plastic tanks	2
	Single-phase synchronous machine	2
	Single-phase 0.5hp water pump	1
	Gears witch/isolator	1
	Changeover switch 30Amps	1
	Prototype hydro turbines (impulse, reaction)	1 each
	Prototype hydro alternators (Assorted)	1 each
	Prototype of wind turbine system (Fabricated)	
	Frequency meter	2
	DC volt meter 0-30V	5
	DC ammeters 0-10Amps	5
	3-Phase wattmeter	1
	Digital tachometer	1
	Torque meter	1
	Dynamometer	1
	Stroboscope	1

	Flowmeters	1
	Manometers	1

Electronics Laboratory

S/N	Equipment	Required Quantity
	Semiconductor Diode Characteristics Apparatus	4
	Analog Lab Trainer Kit	5
	Transistor Characteristics demonstrator	5
	Oscilloscopes: - Single trace 5MHz Probe - Dual trace 15 MHz 5 - 100Mhz	 2 2 1
	Signal generators (AF, RF)	2 each
	Transistor tester	3
	Amplifier Characteristics Apparatus	3
	FET Tester	3
	Power supply unit 0-60v/3A	5 units
	BJT Amplifier Training kit	3
	Feedback Amplifier Trainer Kit	3
	Sweep generator	2
	Multirange DC voltmeters	4
	Multirange AC voltmeter	4
	Multirange AC ammeter	4
	Multirange DC ammeter	4
	Circuit construction deck	10
	DC power supply out-put 0 - 20V/0-2A	5
	Milliameters: 0- 1000m A DC 0- 1000m A AC	 5 5
	Microammeter:	

	0- 1000 µA DC 0- 1000 µA AC	5 5
	Millivolmeter 0- 1000m V DC	 5
	Galvanometer (triple pole range) 30-0-30m A 500-0500m A 5-0-5m A 10	 10 10 10
	Portable Handheld RLC bridge	2
	Avometer (model 410)	5
	Power Electronics Trainer	4
	Universal IC Tester	4
	Digital Electronics Trainer Digital Trainer Kit Digital IC Trainer Flip Flop Trainer	 1 2 2

Fluid Mechanics/Hydraulics Lab

S/N	Description of Equipment	No. Required
1.	Hydraulics Bench with accessories for various experiments in fluid flow measurements	1
4	Floating Body Apparatus	1
5.	Manometer	1
6.	Rotameter	1
7.	Laminar/turbulent pipe flow apparatus	1
8.	Pilot static tube	1

Thermodynamics Lab

2	Uncalibrated mercury in glass thermometer 10° to 110°C	25

3	Resistance thermometer	1
9	Tachometer	1
10	Stroboscope	1
16	High pressure vapour unit	1
17	Vapour density apparatus	1
18	Pressure cooker	1
19	Falling ball viscometer	1
20	Rotary viscometer	1
21	Gas laws apparatus	1
27	Fire extinguishers	4
28	Sand and water buckets	4
29	Air thermometer constant volume	4

Drawing Studio

1	Drawing table complete with drafting machine/stood	30
2	Drawing set complete with pens for ink work	2
3	45^o set squares	2
4	60^o set squares	2
6	Adjustable set squares	5
7	Desk sharpener	5
8	Triangular scale rule (30 mm)	5
9	Flat scale rule (300 mm)	5
10	Blackboard ruler (1m)	4-1
11	Blackboard Tee squares	4-1
12	Blackboard set square (45^o, 60^o)	4 each-2
13	Blackboard compasses	4-1
14	Blackboard protractor	4-1

15	French curve set	5
16	Letter stencils (3 mm, 6 mm, 7 mm and 10 mm)	5 each
17	Rubber stencils (3 mm, 6 mm, 7 mm, 6 mm and 10 mm)	5 each
18	Erasing stencils	5 each
19	Drawing rack/shelves for 30 students	
20	Personal computers	2

Computer Studio

S/N	Name	Quantity
	RE Software RETScreen System Advisor Model (SAM) Energy Plus OpenDSS Model for Analysis of Energy Demand Microsoft Applications AUTO-CAD Electrical, VISIO Multisim EdrawMax Smart Draw Electronic Workbench or Multisim Proteus	1 each

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