



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







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:
 - 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 <u>TWO</u> 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 | А | 4.00 |
| 70% - 74% | AB | 3.50 |
| 65% - 69% | В | 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,





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- 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 | СН | |
|-------------|-----|-----------------------------|--------------------------------------|----|----|----|----|--|
| | 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 | |
| TIONALBOARD | | | | | | | | |
| | | LUDE LUSIVE DEVELOPMENT POI | LICIES 12 | | | | | |





YEAR I SEMESTER II

| S/N | Course Code | Course Title | L | P | CU | СН |
|-----|-------------|-------------------------------------|----|----|----|----|
| 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 |
| | | opfor | 17 | 10 | | 54 |
| | | ONAL BOARD FOR | | | | |





YEAR II SEMESTER I

| | S/N | Course Code | Course Title | L | P | CU | СН |
|--------------------|-----------|-------------------------|---|----|---|----|----|
| | 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 | | 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 |
| | | | 14 | | | | |
| KNOWLEDGE PLATFORM | ON INCLUS | SIVE DEVELOPMENT POLICI | ES | | | | |







YEAR II SEMESTER II

| S/N | Course Code | Course Title | L | Р | CU | СН |
|-----|----------------------|--|---|---|----|----|
| 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 | Ċ | 7 | 5 | 16 | 16 |
| | | MALBOMBORT | | | | |
| | JSIVE DEVELOPMENT PO | 15 | | | | |







Introduction to Renewable Energy

| Int PROGRAMME: NATIONAL DIPLOMA RENEWA | roduction to Renewable Energy BLE ENERGY TECHNOLOGY | CATION |
|---|--|------------------------|
| COURSE TITLE: Introduction to Renewable | Course Code: RET 111 | Contact Hours: 3 |
| Energy | 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 Rei | newable Energy |
| GENERAL OBJECTIVES: On completion of this cours 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 sy 6.0 Know the concept and application of biomass energy 7.0 Understand the concept and application of geotherm | e, the students should be able to: ystems | |
| 8.0 Understand the concept of energy storage system | \mathbf{O} | |







| PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY | | | | | | | | | |
|---|--|---|------------------------------------|-------------------------------------|---------------------------------------|--------------------------|--|--|--|
| COURSE TITLE: Introduction to | | Course Code: RET 111 | | (| Contact Hours: 3 | | | | |
| Renewa | ble Energy | Credit Unit: 3 | | r | Theoretical: 1 | | | | |
| Year: I | Semester: I | Pre-requisite: | | Practical: 2 Hour/week | | | | | |
| COURS | SE SPECIFICATION: THEOR | RETICAL AND PRACTICA | AL | | | | | | |
| GOAL: | GOAL: This course is designed to acquaint the students with the knowledge and skills of Renewable Energy | | | | | | | | |
| GENER | GENERAL OBJECTIVE 1.0: Understand the basic concept of Renewable Energy | | | | | | | | |
| THEOR | ETICAL CONTENT | | | PRACTICAL CO | NTENT | | | | |
| Week | Specific Learning Outcome | Teacher's Activities | Resources | Specific Learning Outcome | Teacher's Activities | Resources | | | |
| 1 | 1.1 Define energy | Explain energy | Textbooks Lecture notes | × | | | | | |
| | 1.2 Explain the types of Renewable Energy sources | Describe the types of energy sources | journals Projector PC | | | | | | |
| | 1.3 Explain the classification of energy into renewable and non-renewable | Explain the classification of energy into renewable and non-renewable Explain the advantages | Marker Board Marker Internet | | | | | | |
| | 1.4 Explain the advantages and disadvantages of renewable energy | and disadvantages of renewable energy Explain the advantages | | | | | | | |
| | 1.5 Explain the advantages and disadvantages of non- renewable energy | and disadvantages of non-renewable energy | | | | | | | |
| General | Objective 2.0: Know Renewab | le Energy sources | Γ | | | 1 | | | |
| 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 Diagonal | Discuss Renewable Energy sources Solar thermal Solar PV Wind | journals Projector PC Marker Board Marker Internet | devices/systems: Solar panels Portable windmills Hydropower Biomass | renewable energy devices/systems: Solar panels Portable windmills Hydropower | windmills Hydropower chart Biomass chart |
|---------|---|---|---|---|--|--|
| | Biomass Tidal Geothermal Hydrogen fuel 2.3 Outline the applications of Renewable Energy | Hydro Biomass Tidal Geothermal Hydrogen fuel | | CALEN | Biomass | |
| General | Objective 3.0: Know the conce | Explain the applications of Renewable Energy sources. pt and applications of Sol | ar 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 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 | d onormy | CALEDUCA | Measure solar radiation levels at different time of the day | |
|---|---|--|---|---|---|
| 4.1 Explain wind apargy | Explain wind approx | Taythooks | Identify various | Guida tha students | D rototypa of |
| 4.2 Explain the differenttypes of wind energy systems: | Explain wind energy potentials Explain the different types of wind energy | Lecture notes journals Projector | types/parts of wind turbine. | to: Identify various types/parts of wind turbine. | wind turbine system (Fabricated) |
| • wind Turbines. | systems: | Marker Board | wheasure while speed. | Measure wind | wind vane. |
| • Windmills, | • wind Turbines, | Marker | Measure wind direction. | speed. | |
| • Wind powered Water | • Windmills, | Internet | | | |
| pump, etc | • Wind powered | | | Measure wind direction | |
| 4.3 Explain the components | water pump, etc | | | | |
| of wind energy conversion | Explain the components | | | | |
| system: | of wind energy | | | | |
| | conversion system: | | | | |
| Kotor blades, Uub | Potor blades | | | | |
| • Flub, • Shaft | Hub. | | | | |
| | 3.6 Explain the principles of operation of the following: Solar PV power system Solar cooker Solar cooker Solar distiller Solar distiller Solar thermal power system 3.7 Outline advantages and disadvantages of solar energy Objective 4.0: Know the conce 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. | 3.6 Explain the principles of operation of the following: Solar PV power system Solar cooker Solar cooker Solar distiller Solar distiller Solar thermal power system 3.7 Outline advantages and disadvantages of solar energy Objective 4.0: Know the concept and applications of wire energy potentials 4.2 Explain the different types of wind energy system: wind Turbines, Wind powered Water pump, etc 4.3 Explain the components of wind energy conversion system: Rotor blades, Hub, Shaft. 3.6 Explain the principles of operation of the following: Solar PV power system Solar cooker Solar cooker Solar cooker Solar distiller Solar distiller Solar thermal power system 3.7 Outline advantages and disadvantages of solar energy Objective 4.0: Know the concept and applications of wind energy systems: wind Turbines, Wind powered Water pump, etc 4.3 Explain the components of wind energy conversion system: Rotor blades, Hub, Shaft. | 3.6 Explain the principles of operation of the following: operation of the following: Solar PV power system Solar PV power system Solar cooker Solar cooker Solar water heater Solar water heater Solar distiller Solar distiller Solar thermal power system Solar distiller Solar distiller Solar distiller Solar distiller Solar distiller Solar thermal power system Solar davantages and disadvantages of solar energy Objective 4.0: Know the concept and applications of wind energy potentials Explain advantages of solar energy 4.1 Explain wind energy potentials Explain wind energy potentials Textbooks Lecture notes journals 4.2 Explain the different types of wind energy systems: wind Turbines, Warker Board Marker Internet Windmills, wind Turbines, Warker Board Marker Internet 4.3 Explain the components of wind energy conversion system: Explain the components of wind energy conversion system: Explain the components of wind energy conversion system: Rotor blades, Hub, Rotor blades, Pub. | 3.6 Explain the principles of operation of the following: operation of the following: Solar PV power system • Solar PV power system • Solar cooker • Solar cooker • Solar cooker • Solar cooker • Solar cooker • Solar distiller • Solar thermal power system • Solar thermal power system 3.7 Outline advantages and disadvantages of solar energy Explain advantages of solar energy Explain advantages of solar energy Objective 4.0: Know the concept and applications of wind energy potentials Explain wind energy potentials Textbooks 4.1 Explain wind energy potentials Explain the different types of wind energy systems: Textbooks Identify various types/parts of wind turbines, wind Turbines, wind Turbines, wind nurbines, wind powered Water pump, etc Wind powered Water pump, etc Marker Board Marker Internet 4.3 Explain the components of wind energy conversion system: • Wind powered Water pump, etc Explain the components of wind energy conversion system: • Rotor blades, • Hub, • • Rotor blades, • Hub, • | 3.6 Explain the principles of operation of the following: operation of the following: Measure solar radiation levels at different time of the day • Solar PV power system • Solar PV power system • Solar cooker • Solar water heater • Windi waterer • Windi water heater • Windi ur |













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







| | control system etc | • shaft | | | | |
|---------|--|----------------------------|---------------|----------------------|-------------------------------|--------------|
| | | generator | | | | |
| | | • generator, | | | | |
| | 5.6 Expain the process of | • control system | | | Y V | |
| | hydro turbine power | eic | | | | |
| | extraction | Evaluin the nucleon of | | | | |
| | extraction | Explain the process of | | | | |
| | 5.7 Outline areas of | nydro turbine power | | | | |
| | application of hydronower | extraction | | | | |
| | system | Ortling and of | | | | |
| | system. | Outline areas of | | C XY | | |
| | 5.8 Outline social and | application of | | | | |
| | environmental aspects of | nydropower system. | | Y | | |
| | hydro power systems | Outline second and | | | | |
| | nydro power systems | Outline social and | | | | |
| | | environmental aspects of | | | | |
| 0 1 | | nydro power systems | | | | |
| General | Objective 6.0: Know the conce | pt and application of Bior | nass Energy | I | | |
| 10-11 | 6.1 Define Biomass | Define Biomass | Textbooks | Identify the various | Guide students to: | Prototype of |
| | | | Lecture notes | types of biomass: | | Biomass |
| | 6.2 Explain Biomass energy | Explain Biomass energy | journals | | Identify the various | system |
| | potentials | potentials | Projector | Jatropha carcass | types of biomass: | (fabricated) |
| | | List the types of Biomass | PC | • Sugarcane | | |
| | 6.3 List the types of Biomass | | Marker Board | • Maize, | • Jatropha carcass | |
| | | Explain the Fuel content | Marker | • Animal dung, | Sugarcane | |
| | 6.4 Explain the Fuel content | of various types of | Internet | • Human faeces, etc. | • Maize, | |
| | of various types of | Biomass | | | • Animal dung, | |
| | Biomass | | | Identify Biomass | • Human faeces. | |
| | | Explain the method of | | System components: | etc. | |
| | 6.5 Explain the method of | extracting energy from | | • Digesters | | |
| | extracting energy from | biomass: | | Cylinders | Identify Biomass | |
| | biomass: | Direct | | Bunners | System | |
| | Direct combustion, | combustion, | | | * | |







| | Gasification,Pyrolysis andAnaerobic digestion | Gasification, Pyrolysis and Anaerobic digestion | | Soxhlet extractorsBiodigesters | components:DigestersCylindersBunners | |
|---------|---|---|------------------------------------|---|---|--|
| | 6.6 Explain the principles and mechanism of bioconversion of waste to energy | Explain the principles and mechanism of bioconversion of waste to | | EDUCI | Soxhlet extractors Biodigesters | |
| | 6.7 Explain the principles of biofuel production. | Explain the principles of biofuel production. | | CAL | | |
| | 6.8 State areas of application of biomass energy resources | Explain areas of application of biomass energy resources | A BOH | | | |
| | 6.9 State the advantages and disadvantages of biofuel production | Explain the advantages and disadvantages of biofuel production | | | | |
| General | Objective 7.0: Understand th | e concept and application | of Geothermal | l Energy | | |
| 12-13 | 7.1 Define geothermal energy | Explain geothermal energy | Textbooks Lecture notes | | | |
| | 7.2 Explain geothermal energy potentials | Explain geothermal energy potentials | journals Projector PC | | | |
| | 7.3 Explain types of geothermal energy | Explain types of | Marker Board Marker | | | |
| | systems | geothermal energy systems | Internet | | | |
| | 7.3 Explain types of geothermal energy systems | Explain types of geothermal energy systems | 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 | | EDUCA | | |
|---------|---|--|--|---|---|--|
| General | l Objective 8.0: Understand th | e concept of energy storag | ge systems | | | |
| 14-15 | 8.1 Explain the concept of energy storage | Explain the concept of energy storage | Textbooks Lecture notes journals | Identify various energy storage systems | Guide the students to demonstrate energy storage. | Rechargeabl e batteries Multimeter |
| | 8.2 Explain importance of energy storage | Explain importance of energy storage | Projector PC Marker Board | | energy storage | |
| | 8.3 Explain the following energy storage systems: | Explain the following energy storage systems: | Marker Internet | | | |
| | BiologicalChemical | Biological | | | | |
| | Electrical Electrochemical Mechanical | Chemical Electrical Electrochemica | | | | |
| | • Thermal | l • Mechanical | | | | |
| | 8.4 Explain batteries and accumulators | • I hermal Explain batteries and | | | | |
| | 7.6 Explain fuel cells | accumulators | | | | |







| 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 to | tal score. | | | | | | |







Physics of Renewable Energy Systems

PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY COURSE TITLE: Physics of Renewable Energy Course Code: RET 112 Contact Hours: Systems 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







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| PROG | RAMME: NATIONAL RENE | WABLE ENERGY TECH | INOLOGY | | | | | |
|-------|---|---|--|---------------------------|------------|-------------------------|-----------|--|
| COURS | SE TITLE: PHYSICS OF RE | COURSE CODE: RET 1 | 12 | | Contac | Contact Hours: 2 | | |
| SYSTE | MS | Credit Unit: 2 | | | Theore | etical: 1 | | |
| Year: | I Semester: I | Pre-requisite: | | | Practic | ractical: 1 | | |
| COURS | SE SPECIFICATION: THEOF | RETICAL AND PRACTICA | AL | | | | | |
| GOAL | This course is designed to acqu | aint the students with the k | nowledge and skill | lls of Physics a | oplication | n in Renewable E | nergy | |
| GENEI | RAL OBJECTIVE 1.0: Unders | tand the concept of Energy | | | | | | |
| THEOR | ETICAL CONTENT | | | PRACTICAL | CONTE | ENT | | |
| Week | Specific Learning Outcome | Teacher's Activities | Resources | Specific Learn Outcome | ning | 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. | Explain the primary energy sources. | | | | |
|---------|--|--|--|----|---|----------|
| | 1.5 Explain energy transfer processes | Explain energy transfer processes | | CA | Y | |
| | 1.6 Explain the concept of energy and power | Explain the concept of energy and power | | ED | | |
| | 1.7 Explain energy flow and energy flow principles; Primary energy Secondary energy Final energy Useful energy | Explain energy flow and energy flow principles; Primary energy Secondary energy Final energy Useful energy | TECHN | | | |
| General | Objective 2.0: Understand Ther | modynamics and Energy | | | | <u> </u> |
| | 2.1 Explain thermodynamics | Explain thermodynamics | Textbooks, | | | |
| | and energy relationship | and energy relationship | Lecture notes, | | | |
| | 2.2 Explain closed and open Systems: Surroundings Boundaries | Explain closed and open Systems: • Surroundings • Boundaries | Journals Marker Markerboard PC Projector internet | | | |
| | 2.3 Describe macroscopic and microscopic forms of energy | Discuss macroscopic and microscopic forms of energy | | | | |
| | | Discuss the properties of a System | | | | |







| 2.4 Desc a Sys 2.5 Expla • S • P • P te 2.6 Expla | ribe the properties of stem ain the following; tate and equilibrium Processes and Cycles Pressure and emperature ain energy forms and | Explain the following: State and equilibrium Processes and Cycles Pressure and temperature Explain energy forms and their conversion processes | | ALEDUCA | | |
|--|--|--|-----------------------|--|--|--|
| their | conversion processes | | | Y | | |
| General Objective | 3.0: Understand Phys | ics of Solar and Wind Ener | gy Resources | | | |
| 3 1 Evol | ain the physics of | Explain the physics of | Textbooks | Test solar energy | Guida students to: | Multimeter |
| 5.1 Expl | ani the physics of | Solar Energy | Lecture notes | Plot the V I | Test solar energy | Solar cells |
| Solar | Ellergy. | Solar Energy. | Lecture notes, | characteristics of solar | Plot the V I | 10w solar papel |
| 2 2 E1 | | Explain anaroy harvest | Journais | cell and determine the | characteristics of | Voltage probe |
| 3.2 Expla | ain energy narvest | from Solar | Markerboard | Fill Factor (FF) | solar cell and | Current probe |
| from | Solar | Hom Solar | PC | | determine the Fill | Light sensor |
| 3.3 Expl of so energ | ain the characteristics lar radiation as an gy source | Explain the characteristics of solar radiation as an energy source | Projector internet | Measure the effect of PV panel temperature on output power generation | Factor (FF) Measure the effect of PV panel | K-type thermocouple 1000w Tungsten balogon |
| 3.4 Expla solar electr | ain conversion of the radiation to the ricity | Explain conversion of the solar radiation to the electricity | | | output power generation | discharge lamp, Color filters |
| 3.5 Expla proce | ain the basic esses in photovoltaics | Explain the basic processes in | | | | |















| | 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 | THOM | | | |
|---------|---|---|--|---|--|----------------------------------|
| Cananal | Ohistica 4.0. Kusan Dhasisa (| Lift-Type Rotors | | | | |
| General | Objective 4.0: Know Physics of 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 | Tidal, Hydropower and Ge 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 | Resources 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 | Explain Tidal Energy | | | |
|-------------------------------|---------------------------|--------------|----|--|
| characteristics | Technologies | | | |
| endracteristics | reennoiogies | | C | |
| | Evaluin occor thermal | | | |
| 4.5 Explain Tidal Energy | Explain ocean thermal | | CX | |
| Technologies | energy | | | |
| | | | | |
| 4.6 Explain ocean thermal | Explain the concept of | | | |
| energy | osmotic power | | | |
| energy | _ | | | |
| | Explain ocean biomass. | | | |
| 4.7 Explain the concept of | I | . (| | |
| osmotic power | Explain the basic concept | | | |
| | of goothermal energy | | | |
| | of geothermal energy | | | |
| 4.8 Explain ocean biomass | | | | |
| | Explain geothermal | | | |
| 4.0 Eveloin the basic concept | technologies. | \mathbf{X} | | |
| 4.9 Explain the basic concept | | | | |
| of geothermal energy | Explain the use of | | | |
| | Geothermal Energy | Y | | |
| 4.10 Explain geothermal | | | | |
| technologies. | Explain hydropower | | | |
| 8 | resources | | | |
| 111 Explain the use of | | | | |
| | Explain basis soneant of | | | |
| Geothermal Energy | Explain basic concept of | | | |
| | nyuropower technologies | | | |
| 4.12 Explain hydropower | | | | |
| resources, | Explain the | | | |
| | environmental impact of | | | |
| 4.13 Explain basic concept | hydro power sources. | | | |
| of hydronower | | | | |
| | | | | |
| technologies | | | | |
| | 1 | | | |







| General | Objective 5.0: Understand Phot | coelectrolyzers and Photosyn | nthesis | | | |
|---------|--------------------------------|------------------------------|----------------|------------------------|--------------------|------------|
| | 5.1 Explain the basic concept | Explain the basic concept | Textbooks, | | | |
| | of Photoelectrolyzers | of Photoelectrolyzers | Lecture notes, | | | |
| | 5 | | Journals | | × ´ | |
| | 5.2 Explain the basic concept | Explain the basic concept | Marker | | | |
| | of Photosynthesis | of Photosynthesis | Markerboard | | | |
| | 5 3 Explain general | | PC | | | |
| | considerations of biomass | Explain general | Projector | | | |
| | considerations of biomass | considerations of | Internet | | | |
| | usage | biomass usage | | | | |
| | | | | | | |
| | 5.4 Explain biophysical | Explain biophysical | | | | |
| | principles of | principles of | | 7 | | |
| | photosynthesis | photosynthesis | XY | | | |
| | | | | | | |
| | 5.5 Explain basic | Explain basic | | | | |
| | biomolecular processes of | biomolecular processes | | | | |
| | photosynthesis | of photosynthesis | | | | |
| | | | Y | | | |
| | 5.6 Explain photon | Explain photon | | | | |
| | absorption and energy | absorption and energy | | | | |
| | transfer in the light- | transfer in the light- | | | | |
| | harvesting of | harvesting of | | | | |
| | photosystems | photosystems | | | | |
| | F | | | | | |
| General | Objective 6.0: Know Energy Co | onversion and Storage | | | | |
| | 6.1 Explain the basic concept | Explain the basic concept | Textbooks, | Identify the types of | Guide students to: | Capacitors |
| | of Photoelectrolyzers | of Photo-electrolyzers | Lecture notes, | batteries | Identify the types | Flywheels |
| | | | Journals | Identify the | of batteries | Pumped |
| | | Explain conversion of | Marker | components of the | Identify the | Hydropower |
| | | raw materials into usable | Markerboard | batteries above | components of the | Compressed |
| | | energy | PC | Identify the following | batteries above | Air Energy |







| 6.2 Ex | plain conversion of raw | Explain storage of the | Projector | storage systems: | Identify the | Storage |
|---|--|--|-----------|---|--|---------------------------------|
| ma | aterials into usable | energy produced in | internet | Capacitors | following storage | (CAES) |
| ene | ergy | energy conversion | | • Flywheels | systems: | Pumped Heat |
| 6.3 Ex end pro 6.4 Ex ele 6.5 Ex tec • • • • • • • • • • • • • • • • • • • | aplain storage of the ergy produced in ergy conversion occess aplain the concept of ectricity storage aplain Storage chnologies; Batteries Capacitors Flywheels Pumped Hydropower Compressed Air Energy Storage (CAES) Pumped Heat Electrical Storage (PHES) aplain the basic concept fuel cell | 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 | | Prywheels Pumped Hydropower Compressed Air Energy Storage (CAES) Pumped Heat Electrical Storage (PHES) | Capacitors Flywheels Pumped Hydropowe r Compressed Air Energy Storage (CAES) Pumped Heat Electrical Storage (PHES) | Electrical Storage (PHES) |
| cel | Il technologies: | | | | | |







| Proton Exchange Membrane Fuel Cells Phosphoric Acid Fuel Cells Solid Oxide Fuel Cells | Phosphoric Acid Fuel Cells Solid Oxide Fuel Cells | COUCHIOT | |
|---|--|---|-------------------------|
| ASSESSMENT: The continuous assessment of the remaining 40% of the to | ment, tests and quizzes will be awa tal score. | arded 60% of the total score. The end of the Se | mester Examination will |
| | | CHINA | |
| | FORT | | |
| | BONRY | | |
| ATIONA | | | |
| KNOWLEDGE PLATFORM ON INCLUSIVE DEVELOPMENT POLICIES | 35 | | |





Basic Chemistry for Renewable Energy System

PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY COURSE TITLE: Basic Chemistry for Renewable Course Code: RET 113 Contact Hours: 2 **Energy System** 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






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| PROGE | PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY | | | | | | |
|---------|--|--|--|---|--|--|--|
| COURS | SE TITLE: Basic Chemistry | Course Code: RET 113 | | | Contact Hours: 2 | | |
| for Ren | ewable Energy System | Credit Unit: 2 | | | Theoretical: 1 | | |
| Year: I | Semester: I | Pre-requisite: | | Practical: 1Hour/week | | | |
| COURS | SE SPECIFICATION: THEOR | RETICAL AND PRACTICA | AL | | | | |
| GOAL: | This course is designed to acqua | aint the students with the kr | owledge and sk | ills on the applicati | ions of chemistry to renewal | ole energy | |
| GENER | RAL OBJECTIVE 1.0: Unders | stand the basic chemistry of | biomass and bio | ofuels | 2 | | |
| THEOR | RETICAL CONTENT | | | PRACTICAL CO | DNTENT | | |
| Week | Specific Learning Outcome | Teacher's Activities | Resources | Specific Learning Outcome | g 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 • Hemicellulos • Lignin, etc. Explain the biomass conversion processes: • Thermochemi cal (gasification, pyrolysis) • Biological (fermentation | Textbooks, Lecture notes, Journals Marker Markerboard PC Projector internet | Identify the various sources to produce biodiesel, bioetha and biogas Demonstrate simp fermentation, transesterification anerobic digestion processes for the conversion of bio into biofuels | us Guide students to: the Guide students to: the Guide students to: the Guide students to: the Guide students to: sources to produce biodiesel, bioethanol and biogas n and n Demonstrate simple transesterification and anerobic digestion processes for the conversion of biomass into biofuels | Feedstock Laboratory chemicals and reagents, | |







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















| | 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 h | asic chemistry of hydrogen | and fuel cells | | |
| General | 2.1 Europein the sherristant of | Evaluin the chamistry of | Tarthaalsa | | |
| 6.0 | 3.1 Explain the chemistry of | Explain the chemistry of | I extbooks, | | |
| 0-8 | Nydrogen production: | Nydrogen production: | Lecture notes, | | |
| | Water hydrolysis Diamaga agaification | Water Hydrolysis Diamage | Journals Marker | | |
| | Biomass gasmication | • Biomass | Markerboard | | |
| | • Hydrogen handling (storage and | gasification Hydrogen | PC | | |
| | (storage and transportation) | • Hydrogen handling (storage | Projector | | |
| | transportation) | and | internet | | |
| | 3.2 Define Fuel Cells | transportation) | | | |
| | 3.3 Explain types of fuel cells: | Explain Fuel Cells | | | |
| | Proton exchange | Explain types of fuel | | | |
| | membrane fuel cell | cells: | | | |
| | (PEMFC) | Proton exchange | | | |
| | • Direct methanol fuel cells (DMFC) | membrane fuel cell (PEMFC) | | | |
| | Phosphoric acid fuel | Direct methanol | | | |
| | cells (PAFC) | fuel cells | | | |
| | • Solid oxide fuel cells | (DMFC) | | | |
| | (SOFC) | Phosphoric acid | | | |
| | • Molten carbonate fuel | fuel cells | | | |
| | cells (MCFC) | (PAFC) | | | |







| | 3.4 Explain the areas of fuel cells application | Solid oxide fuel cells (SOFC) Molten carbonate fuel cells (MCFC) | | | | |
|---------|---|--|--|-------------------------------------|--|---------------|
| | | cells application | | | | |
| General | Objective 4.0: Know Renewabl | e Energy storage and mater | ials chemistry | | | |
| 9-11 | 4.1 Define battery | Explain battery | Textbooks, Lecture notes, | Identify different types of battery | Guide the students to | Batteries and |
| | 4.2 Explain different types of | Explain different types | Journals | | | measuring |
| | batteries | of batteries | Marker | Measure battery | Identify different | devices |
| | Primary batteries (zinc carbon cells, alkaline batteries, silver oxide 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 | 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) | Markerboard PC Projector internet | efficiency parameters | types of battery Measure battery efficiency parameters measure battery quality parameters | |







| | 4.4 Explain the materials for | Explain the properties of | | | | |
|---------|---------------------------------|---------------------------|----------------|--------------------------|---|--|
| | battery electrodes and | Primary and secondary | | | | |
| | electrolytes | batteries and their uses | | C | | |
| | | | | | Y | |
| | 4.5 Define super capacitors | Explain the materials for | | | | |
| | no Dennie super eupuenons | battery electrodes and | | | | |
| | 4.6 Explain types of | electrolytes | | | | |
| | supercapacitors | electrolytes | | | | |
| | supercupacitors | Explain super capacitors | | | | |
| | 4.7 Explain the mechanism of | Explain super cupacitors | | | | |
| | RE storage | Explain types of | | C Y | | |
| | KE storage | supercapacitors | | | | |
| | | supercapacitors | | | | |
| | | Explain the mechanism | | | | |
| | | of PE storage | | | | |
| Conorol | Objective 5.0. Understand the h | of KE storage | (araan) ahamia | two and comb on continue | | |
| | 5 1 Define Creen Chemistry | Explain Crean | Touth a also | and carbon capture | | |
| 12-14 | 5.1 Define Green Chemistry | Explain Green | Textbooks, | | | |
| | COE 1 : (11) | Chemistry | Lecture notes, | | | |
| | 5.2 Explain sustainable | | Journals | | | |
| | chemical processes | Explain sustainable | Marker | | | |
| | | chemical processes | Markerboard | | | |
| | 5.3 Explain bioplastics | | PC | | | |
| | production from biomaterials | Explain bioplastics | Projector | | | |
| | | production from | internet | | | |
| | 5.4 Explain the concept of | biomaterials | | | | |
| | Carbon Capture | | | | | |
| | | Explain the concept of | | | | |
| | 5.5 Explain the chemical | Carbon Capture | | | | |
| | process of Carbon capture | | | | | |
| | | Explain the chemical | | | | |
| | 5.6 Describe the materials for | process of Carbon | | | | |
| | Carbon storage | capture | | | | |







| | | Discuss the materials for Carbon storage | | | | |
|----------|----------------------------------|---|------------------|-----------------------------|-----------------------|-----------|
| | | • | | | | |
| ASSES | SMENT: The continuous assess | ment, tests and quizzes will | l be awarded 609 | % of the total score. The e | nd of the Semester Ex | amination |
| will mal | ke up for the remaining 40% of t | he total score | | CX | Υ | |







RENEWABLE ENERGY AND ENVIRONMENT

| COURSE TITLE: RENEWABLE ENERGY AND | Course Code: RET 121 | Contact Hours: 3HRS/WK |
|--|--|---------------------------------------|
| ENVIRONMENT | 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 respective effects on the environment. | knowledge and skills of the diffe | erent renewable energy sources and th |
| GENERAL OBJECTIVES: On completion of this cours | se, the students should be able to: | |
| 1.0 Understand the concept of environment | | |
| 2.0 Know the different renewable energy sources | I 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 w | vork environments | |
| 6.0 Understand the basic principles of environmental im | pact assessment (EIA) | |
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| PROGI | RAMME: NATIONAL DIPLO | MA IN RENEWABL | LE ENERGY | | AU' | | |
|---|----------------------------|-------------------------|------------------|----------------------|-------------------------|--------------|--|
| COURS | SE TITLE: RENEWABLE | COURSE CODE: R | ET 121 | Cont | act Hours: 3HRS/WK | | |
| ENERG | Y AND ENVIRONMENT | Credit Unit: 3 | | Theoretical: 1 | | | |
| Year: | I Semester: II | Pre-requisite: NIL | | Pract | 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 re- | | | | eir respective | | | |
| effects of | on the environment. | | | | | | |
| GENE | RAL OBJECTIVE 1.0: Underst | tand the concept of env | rironment | | | | |
| THEOI | RETICAL CONTENT | | L. | PRACTICAL CONT | ENT | | |
| Week | Specific Learning Outcome | Teacher's | Resources | Specific Learning | Teacher's | Resources | |
| | | Activities | | Outcome | Activities | | |
| 1-2 | 1.1 Define Environment | Explain | Textbooks, | Detect the prevalent | Guide students | Thermometer, | |
| | | Environment | Lecture notes, | environmental | to: | Barometer, | |
| | 1.2 Explain the concept of | | Journals Marker | conditions in the | Measure different | temperature | |
| | Environmental health | Explain the concept | Markerboard | immediate environmen | it. environmental | probes air | |
| | | of Environmental | PC | | parameters. | velocity | |
| | 1.3 Explain the different | health | Projector | | | meter, solar | |
| | types of environment: | | internet | | | irradiation | |
| | • Physical environment | Explain the different | | | | sensor, | |
| | Biological | types of | | | | Pyranometer | |
| | environment | environment: | | | | | |
| | Chemical | • Physical | | | | | |
| | environment | environment | | | | | |
| | Social or cultural | • Biological | | | | | |
| | environment | environment | | | | | |
| | | • Chemical | | | | | |
| | 1.4 Explain the following; | environment | | | | | |
| | Carbon Emission | | | | | | |
| | | | | | | | |







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















| | | Waste, etc | | | | | |
|---------|---|-----------------------|-----------------|------------------------|-------------------|--------------|--|
| | | | | | | | |
| General | Jeneral Objective 3.0: Understand the relationship between RE sources and the environment | | | | | | |
| 5-7 | 3.1 Explain the basic concept | Explain the basic | Textbooks, | Establish the | Conduct | Solar | |
| | of RE sources and | concept of RE | Lecture notes, | relationship and | assessment on the | irradiation | |
| | environment relationship | sources and | Journals Marker | interaction between RE | different | sensor, | |
| | | environment | Markerboard | sources and different | environments. | tachometer, | |
| | 3.2 Explain the differences | relationship | PC | environments. | | manometer, | |
| | between the Quality and | | Projector | | | anemometer, | |
| | quantity of sun for different | Explain the | internet | | | biodigester, | |
| | environments | differences between | | | | pulverizer, | |
| | | the Quality and | | | | | |
| | 3.3 Explain the differences | quantity of sun for | | | | | |
| | between quality and quantity | different | | | | | |
| | of wind for different | environments | | | | | |
| | environments | 5 1 1 1 | · · · | | | | |
| | | Explain the | | | | | |
| | 3.4 Explain the topography of | differences between | O^{r} | | | | |
| | water bodies/site | quality and quantity | | | | | |
| | | of wind for different | | | | | |
| | 3.5 Explain the different | environments | | | | | |
| | types of waste available on | Evelopethe | | | | | |
| | site | Explain the | | | | | |
| | 3.6 Explain the reduction of | bodios/site | | | | | |
| | 5.0 Explain the feduction of | boules/site | | | | | |
| | arbon omissions | Explain the different | | | | | |
| | | types of waste | | | | | |
| | 3.7 Explain the reduction of | available on site | | | | | |
| | dependence on fossil fuels | | | | | | |
| | dependence on rossil rueis | | | | | | |







| | 3.8 Explain the impact of 3.6 | Explain the | | | | |
|---------|---------------------------------|-----------------------|-----------------------|--------------------------|---|----------|
| | on irrigation farming and | reduction of the | | | | |
| | erosion control | usage of fossil fuels | | | | |
| | | and carbon | | | Y | |
| | 3.9 Explain the reduction of | emissions | | | | |
| | organic waste. | | | | | |
| | | Explain the | | | | |
| | | reduction of | | | | |
| | | dependence on fossil | | | | |
| | | fuels | | | | |
| | | | | CY | | |
| | | Explain the impact | | | | |
| | | of 3.6 on irrigation | | * | | |
| | | farming and erosion | | | | |
| | | control | | | | |
| | | | | | | |
| | | Explain the | | | | |
| | | reduction of organic | Q' | | | |
| | | waste | | | | |
| General | Objective 4.0: Understand the r | nanagement of RE soli | d wastes and their ef | fects on the environment | | <u> </u> |
| 8-9 | 4 1 Define solid wastes | Explain solid wastes | Textbooks | | | |
| 0) | 1.1 Define softe wastes | Explain solid wastes | Lecture notes | | | |
| | 4.2 Explain the effects of RF | Explain the effects | Lournals Marker | | | |
| | solid wastes on the | of RF solid wastes | Markerboard | | | |
| | environment | on the environment | PC | | | |
| | environment | on the environment | Projector | | | |
| | 4.3 Explain the means of | Explain the means | internet | | | |
| | recycling electronic wastes | of recycling | momer | | | |
| | digestate/effluent_etc | electronic wastes | | | | |
| | digestate/enruent, etc. | digestate/effluent | | | | |
| | | etc. | | | | |
| | | digestate/effluent, | | | | |







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







| | 1 | |
|---|-----------------------------|---|
| | Explain | |
| | environmental | |
| | andita | |
| | audits. | |
| | | |
| | Explain EIA and | |
| | FIS for any two | |
| | | |
| | different projects | |
| ASSESSMENT: The continuous assess | nent, tests and quizzes wil | 11 be awarded 60% of the total score. The end of the Semester Examination |
| will make up for the remaining 40% of the | ne total score | |
| the man of the termining 1070 of the | | |
| | | ATECHNICK |
| | BOUBDE | |
| INCLUDE KNOWLEDGE PLATFORM ON INCLUSIVE DEVELOPMENT POLICIES | | 51 |







Introduction to Digital Electronics

| PROGRAMME: NATIONAL DIPLOMA RENEWABL | E 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 electronic digital | conics system |
| GENERAL OBJECTIVES: On completion of this course | se, 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 | FCHMCM | |
| BOHR | DFOR | |
| AAIONAL | | |
| JCLUDE PLATFORM ON INCLUSIVE DEVELOPMENT POLICIES | 52 | |





| PROG | RAMME: NATIONAL DIP | PLOMA RENEWAB | LE ENI | ERGY TECHNO | DLOGY | | |
|---------|--|--|------------------------|---|---------------------------------------|--|--------------------------------------|
| COUR | SE TITLE: Introduction to 2 | Digital C | COURS | E CODE: RET | C 122 | CONTACT HOURS: 3 | |
| Electro | nics | | CREDI | Г UNIT: 3 | ŗ | THEORETICAL: 2 | |
| YEAR | I SEMESTER: I | P | RE-RF | EOUISITE: | 1 | PRACTICAL: 1 | |
| COUR | SE SPECIFICATION TH | EORETICAL AND | PRACT | | | | |
| GOAL | : This course is designed to e | equip student with the | e knowl | edge and skills | of digital electronics | s system | |
| Genera | al Objective 1.0: Know the | basic concept of Num | ber Sys | stem | | · | |
| THEO | RETICAL CONTENT | | | | PRACTICAL CO | NTENT | |
| Week | Specific Learning Outcome | Teacher's Activitie | s | Resources | Specific Learning Outcome | Teacher's Activities | Resources |
| 1-3 | 1.1 Explain analog and digital signals | Explain analog and o signals | digital | Textbooks Journals Charts | Demonstrate conve from decimal and | Guide students to: ersionDemonstrate conversion from | Digital Logic Trainers |
| | 1.2 Explain applications of digital and analog signals. | Explain applications digital and analog si | s of gnals. | Animations Computer Projector Marker | hexadecimal | decimal and hexadecimal | DMM. Bench Power Supply. |
| | 1.3 Explain the advantages of analog and digital signals. | Explain the advantag analog and digital si | ges of gnals | Marker Board | | | Function Generator. Breadboard |
| | 1.4 Explain binary, octal, and hexadecimal number system | Explain binary, octa hexadecimal number system | l, and r | | | | Oscilloscope. |
| | 1.5 Explain conversion from decimal and hexadecimal to binary and vice-versa. | Explain conversion a decimal and hexaded to binary and vice-ve | from cimal ersa. | | | | |







| | 1.6 Explain binary addition | Explain binary addition | | | | |
|--------|-----------------------------|------------------------------|--------------|-------------------------|------------------------|---------------|
| | and subtraction | and subtraction, | | | | |
| | 1.7 Explain the | Explain the | | | | |
| | addition/subtraction of | addition/subtraction of 1's | | ~ | | |
| | 1's and 2's complement | and 2's complement | | | | |
| Genera | d Objective 2.0: Understand | Logic Gates | | | | |
| 4-6 | 2.1 Explain logic gate | Explain logic gate | Textbooks | | Guide Students to: | Digital Logic |
| | | | Journals | Investigate the logical | Investigate the | Trainer. |
| | 2.2 Explain the basic | Explain the basic concept | Computer | behavior of AND, OR, | logical behavior of | |
| | concept of negative and | of negative and positive | Internet | NOT, NAND, NOR, | AND, OR, NOT, | Logic gates. |
| | positive logic, | logic, | Projector | and EX-OR gates. | NAND, NOR, and | |
| | | | Marker | | EX-OR gates. | DMM. |
| | 2.3 Define truth table. | Explain truth table. | Marker Board | Y | | |
| | | | | Show the NAND gate | Demonstrate and | Bench Power |
| | | | | as a Universal Gate | snow the NAND | Supply. |
| | 2.4 Explain the symbols and | Explain the symbols and | QY | | gate as a Universal | |
| | truth tables of NOT, | truth tables of NOT, AND, | | T () (1) 1 1 | Uale | Digital Logic |
| | AND, UK, | OR, NAND, NOR, EXOR | \bigcirc | Interpret truth tables | Interpret truth tables | I rainer. |
| | NAND, NOR, EXOR | Gates | | for logic gates | for logic gates | Ennetion |
| | Gales | | | | for logic gales | Function |
| | 2.5 Describe the NAND and | Explain the NAND and | | | | Generator. |
| | NOR as universal gates | NOR as universal gates | | | | Breadboard |
| | NOR as universal gates. | ivor as universal gates. | | | | Dicadooard. |
| | 2.6 Explain interpretation | Explain interpretation truth | | | | Oscilloscope |
| | truth tables for logic | tables for logic gates | | | | osemoseope. |
| | gates | label for logic gales | | | | |
| | ganes | | | | | |
| | 2.7 Describe the integrated | Explain the integrated | | | | |
| | circuit logic | circuit logic | | | | |
| | | _ | | | | |







| | 2.8 Explain the concept of | Explain the concept of | | | | |
|--------|-------------------------------|------------------------------|--------------|-------------------------|----------------------|---------------|
| | integrated circuit Logic | integrated circuit Logic | | | | |
| | families. | families. | | | | |
| | | | | | | |
| | 2.9 Explain the TTL and | Explain the TTL and | | | | |
| | CMOS logic families | CMOS logic families | | | | |
| Genera | al Objective 3.0: Know Logi | c Simplification and its App | lications | | | |
| 7-8 | 3.1 Explain the concept of | Explain the concept of | Textbooks | | Guide the students | Digital Logic |
| | Boolean algebra | Boolean algebra | Journals | | to: | Trainer. |
| | | | Computer | Verify Boolean Laws | Verify Boolean | |
| | 3.2 Explain the | Explain the | Internet | using the various logic | Laws using the | Logic gates. |
| | implementation of the | implementation of the | Projector | gates | various logic gates | |
| | Boolean (logic) | Boolean (logic) equation | Marker | | | DMM. |
| | equation with gates | with gates | Marker Board | Construct the truth | Construct the truth | |
| | | | | table of various logic | table of various | Bench Power |
| | 3.3 Explain Karnaugh map | Explain Karnaugh map up | | gates and combination | logic gates and | Supply. |
| | up to 4 variables | to 4 variables | A Y | circuits using logic | combination circuits | |
| | | C | | gates. | using logic | Function |
| | 3.4 Explain the simplicity | Explain the simplicity of | D' | | gates. | Generator |
| | of Karnaugh map | Karnaugh map application | | Evaluate various | | |
| | application in | in developing | | combinational circuits | Design, test, and | Breadboard. |
| | developing | combinational logic | | such as adders, | evaluate various | |
| | combinational logic | circuits | | subtractors, | combinational | Oscilloscope. |
| | circuits | | | | circuits such as | |
| | | | | Design and implement | adders, subtractors, | |
| | 3.5 Explain the half-adder | Explain the half-adder and | | adders and subtractors | | |
| | and full-adder circuit | full-adder circuit | | using logic gates | Design and | |
| | | | | T 1 (11 1 | implementation of | |
| | 3.6 Explain the half and full | Explain the half and full | | implement adders and | adders and | |
| | subtractor circuit. | subtractor circuit. | | subtractors using logic | subtractors using | |
| | | | | gates | logic gates | |
| | | | | | | |







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







| eral Objective 5.0: Understand | Latches, flip-flops, and Cou | inters | | | |
|--------------------------------|------------------------------|--------------|---------------------------|----------------------|---------------|
| 3 5.1 Describe the concept of | Explain the concept of the | Textbooks | | Guide students to: | Digital Logic |
| the latch and flip-flop | latch and flip-flop | Journals | | | Trainer. |
| | | Computer | Evaluate flip-flops, | Construct, test, and | |
| 5.2 Explain the difference | Explain the difference | Internet | counters, and shift | evaluate flip-flops, | IC TRAINER |
| between a latch and a | between a latch and a flip- | Projector | registers. | counters, and shift | kit |
| flip-flop | flop | Marker | | registers. | |
| | | Marker Board | Implement SISO, | | Bench Power |
| 5.3 Explain the working | Explain the working | | SIPO, PISO, and PIPO | Implement SISO, | Supply |
| principle of latch | principle of latch | | shift registers using | SIPO, PISO, and | |
| | | | flip-flops. | PIPO shift registers | Logic Gates, |
| 5.4 Explain the types of | Explain the types of | | | using flip-flops. | Oscilloscope |
| latches | latches | | Verify of 4-bit ripple | | |
| | | | counter and Mod-10, | Construct, test, and | Connecting |
| 5.5 Explain the applications | Explain the applications of | | Mod-12, and Mod-N | verify of 4-bit | Probes |
| of latches | latches | | ripple counters | ripple counter and | |
| | | | | Mod-10, Mod-12, | Logic gates. |
| 5.6 Describe the circuit | Explain the circuit | | | and Mod-N ripple | |
| structure of different | structure of different flip | O' | Simulate various | counters | DMM. |
| flip flops and their | flops and their applications | , | combinational circuits, | | |
| applications | | | sequential circuits flip- | | Bench Power |
| | | | flops, and counters. | Simulate various | Supply. |
| 5.7 Explain the operation of | Explain the operation of T, | | using relevant software | combinational | . . |
| T, D, and Master/Slave | D, and Master/Slave JK | | | circuits, sequential | Function |
| JK flip flops using | flip flops using waveforms | | Interpret Truth Tables | circuits flip-flops, | Generator |
| waveforms and truth | and truth tables. | | for latches, flip flops, | and counters. using | |
| tables. | | | and counters | relevant software | Breadboard. |
| 5.8 Explain the basic | Explain the basic concept | | | Interpret Truth | Oscilloscope |
| concept of counters | of counters | | | Tables for latches, | |
| | | | | flip flops, and | |
| | | | | counters | |







| | 5.9 Explain the following counters: asynchronous and synchronous counters Binary counters Divide by N ripple counters Decade counter Timers Shift registers | Explain the following counters: asynchronous and synchronous counters Binary counters Divide by N ripple counters Decade counter Timers Shift registers | | CALEDU | ATION | |
|--------|---|---|--------------|-----------------------|--------------------|------------------------|
| | 5.10 Explain how to interpret truth tables for latches flip flops and | Explain how to interpret truth tables for latches, flip flops, and counters | | | | |
| | counters | nops, and counters | | | | |
| Genera | l Objective 6.0: Understand | Microcontrollers and Progra | amming | 1 | | L |
| 4-15 | 6.1 Explain the Concept | Explain the Concept | Textbooks | | Guide the students | Computer |
| | Microcontrollers. | Microcontrollers. | Journals | | to: | |
| | | | Computer | Identify the | Identify the | Arduino Uno |
| | 6.2 Explain the Architecture | Explain the Architecture of | Internet | Microcontrollers. | Microcontrollers. | kits |
| | of the following | the following | Projector | T1 | T 1 | Rasbery Pi |
| | Microcontrollers; | Microcontrollers; | Marker | Identify | Identity | Microcontroll |
| | Arduino Uno | Arduino Uno | warker-Board | Insut/Output ports | Witcrocontroller | er Trainer. |
| | • Rasbery Pi | • Rasbery Pi | | nower ping reset and | nower ping reset | |
| | • ATMEGAS and | • ATMEGAS and | | clock nins | and clock pins | IC |
| | • PIC | • PIC | | orook pins. | and crock phils. | Programmer. |
| | | Y | | Perform Basic | Perform Basic | |
| | 6.3 Define Microcontroller Programming | Explain Microcontroller Programming | | Programming. | Programming. | Bench Power supply. |
| | | | | Load the program from | Load the program | |







| | 6.4 Explain Microcontroller | Explain Microcontroller | | PC to microcontroller | from PC to | Breadboard. |
|-------|---------------------------------|---|-----------------|-------------------------|-----------------------|---------------|
| | Programming | Programming | | via programmer. | microcontroller via | |
| | • Instruction set | • Instruction set | | | programmer. | Vero Board. |
| | Programming | Programming | | Setup the hardware | | |
| | Language | Language | | (vero board, | Setup the hardware | Serial Cable. |
| | • C++ | • C++ | | breadboard, | (vero board, | |
| | • Python | • Python | | microcontroller, led, | breadboard, | Sensors. |
| | 5.4.4 | 5 | | sensors, e.t.c) | microcontroller, led, | |
| | 6.5 Explain how to interface | Explain how to interface | | | sensors, e.t.c) | Soldering |
| | with microcontrollers | with microcontrollers and | | Interface | | kits. |
| | and sensors | sensors | | microcontrollers with | Interface | |
| | | | | sensors. | microcontrollers | Computer |
| | 6.6 Explain how to interface | Explain how to interface | | | with sensors. | with |
| | microcontrollers with | microcontrollers with | | | | appropriate |
| | ADC. DAC. or other | ADC, DAC, or other | | | | software |
| | microcontrollers | microcontrollers | | | | |
| | | | | | | |
| ASSES | SMENT: The continuous as | sessment, tests and guizzes | will be awarded | 60% of the total score. | The end of the Semest | er |
| | | , | | | | |

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 | Course Code: RET 211 | Contact Hours: 3 |
|---|--|---------------------------------------|
| INSTALLATION AND MAINTENANCE I | Credit Unit: 3 | Theoretical: 1 |
| Year: II Semester: I | Pre-requisite: | Practical: 2Hour/week |
| GOAL: This course is designed to equip the students System. | with basic knowledge and skills to | install and Maintain Renewable Energy |
| GENERAL OBJECTIVES: On completion of this con 1.0 Understand the fundamentals of RE system install 2.0 Know basic RE System Installation Techniques 3.0 Know basic RE System Maintenance Techniques. | arse, the students should be able to: ation and maintenance | |
| 4.0 Understand Troubleshooting and Maintenance | | |
| | FOL. | |
| A | | |
| | | |
| 80, | | |
| | | |
| | | |
| | | |
| | | |
| NCLUDE | 60 | |





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| PROGI | PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY | | | | | | | |
|----------------|---|--|--|---|---------------------------|--|---|--|
| COURS | SE TITLE: RENEWABLE | Course Code: RET 211 | | | Contact Hours: 3 | | | |
| ENERG MAINT | Y INSTALLATION AND | Credit Unit: 3 | | ~ | Theoret | ical: 1 | | |
| Year: I | I Semester: I | Pre-requisite: | | | Practica | al: 2Hour/week | | |
| COURS | COURSE SPECIFICATION: THEORETICAL AND PRACTICAL | | | | | | | |
| GOAL: | 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 fu | indamentals of RE system i | nstallation and r | naintenance | | | | |
| THEOR | ETICAL CONTENT | | | PRACTICAL CO | ONTEN | Г | | |
| Week | Specific Learning Outcome | Teacher's Activities | Resources | Specific Learning Outcome | 8 | 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 | Explain installation in RE system Explain Installation maintenance in RE system Explain the role of installation and | Textbook Journal PC Projector Marker Marker Board Internet | Identify Graphica symbols in install of RE system Draft RE Symbol Using RE Softwa Produce wiring/connection | al lation ls are | Guide students to: Identify Graphic symbols in installation of RE system Draft RE Schematic Symbols Using RE Software | Drawing instruments Computers AUTO-CAD Electrical, VISIO Multisim EdrawMax Smart Draw | |
| | installation and maintenance in RE system 1.4 Explain RE system components 1.5 Explain RE codes and regulations | maintenance in RE system Explain RE system components Explain RE codes and regulations | | diagram for RE s | u ystem | Produce wiring/connection diagram for RE system | Sinari 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 | | EDUCA | | |
|---------|---|---|---------------------|-------------------------------------|-------------------------------|------------------------------|
| General | Objectives 2.0 Know basic RE | System Installation Technic | ques | | 1 | |
| 3-6 | 2.1 Explain Installation of | Explain Installation of | Textbook | Draw the wiring | Guide students to: | PPE |
| | RE Wiring Systems | RE Wiring Systems | Journal PC | diagram of RE system | Draw the wiring diagram of RE | Multimeter Electrical and |
| | 2.2 Explain Installation of | Explain Installation of | Projector | Connect RE Protective | system | mechanical |
| | RE Protection Devices | RE Protection Devices | Marker Board | Devices | Connect RF | Tool kit |
| | 2.3 Explain Installation of RE Appliances and | Explain Installation of RE Appliances and | Internet | Connect RE Appliances and Equipment | Protective Devices | |
| | Equipment | Equipment | | | Connect RE | |
| | 2.4 Explain RE System | Explain RE System | | and testing of RF | Appliances and Equipment | |
| | inspection and testing | inspection and testing | | installation | Equipment | |
| | inspection | inspection | | | Carry out | |
| | | | | | inspection and | |
| | | No. | | | installation | |
| GENER | RAL OBJECTIVE 3.0: Know b | basic RE System Maintenar | nce Techniques. | 1 | | 1 |
| 7-11 | 3.1 Explain how to Set up a | Explain how to Set up a | Textbook | Identify RE Codes and | Guide students to: | PPE |
| | basic RE maintenance | basic RE maintenance | Journal | regulations | | |
| | Plan | Plan | PC | | Identify RE Codes | IEE |
| | | | Projector Marker | | and regulations | regulations |







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







| 4.2 List troubleshooting | List troubleshooting | Marker | |
|----------------------------|-----------------------|--------------|--|
| methods in RE installation | methods in RE | Marker Board | |
| Regular cleaning and | installation | Internet | |
| inspection | Regular cleaning | | |
| Addressing potential | and inspection | | |
| issues | Addressing | | |
| Performance Data | potential issues | | |
| Analysis | Performance | | |
| Electrical Testing | Data Analysis | | |
| _ | Electrical Testing | | |
| 4.3 List Maintenance | | | |
| measures Renewable Energy | Explain Maintenance | | |
| Installations: | measures Renewable | | |
| General check | Energy Installations: | C X Y | |
| Cleaning | General check | | |
| Data monitoring | • Cleaning | | |
| • Electrical testing | Data monitoring | Y | |
| | • Electrical testing | | |

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.



ONA *





RENEWABLE ENERGY TECHNOLOGY AND APPLICATION I

| PROGRAMME: NATIONAL DIPLOMA RENEV | WABLE ENERGY TECHNOLOG | GY |
|--|--|-------------------------------------|
| COURSE TITLE: RENEWABLE ENERGY | Course Code: RET 212 | Contact Hours: 3 |
| TECHNOLOGY AND APPLICATION I | Credit Unit: 3 | Theoretical: 1 |
| Year: II Semester: I | Pre-requisite: | Practical: 2Hour/week |
| GOAL: This course is designed to acquaint students applications | with the knowledge and skills of bas | sic Renewable Energy technology and |
| GENERAL OBJECTIVES: On completion of this co | ourse, the students should be able to: |)* |
| Understand Basic Concepts of Renewable Energy Know Basic Solar Energy Technology Know Basic Wind Energy Technology Understand Basic Geothermal & Hydroelectric E Know Basic Biomass Technology | y Technology nergy Technology | |
| 5.0 Know Dasic Diomass Technology | | |
| AALBOA | R | |
| ICLUDE | 65 | |
| | | |
| | | |







| PROG | RAMME: NATIONAL DIPLC | MA RENEWABLE ENE | RGY TECHNO | DLOGY | | | |
|---|---|---|------------------------------------|---|----------------|---|-------------|
| COURSE TITLE: RENEWABLECOURSE CODE: RET 212 | | | | Contact | Hours: 3 | | |
| ENERG APPLIC | Y TECHNOLOGY AND CATION I | Credit Unit: 2 | | | Theoretical: 1 | | |
| Year: | I Semester: I | Pre-requisite: | | | Practica | ıl: 2 | |
| COURS | SE SPECIFICATION: THEOR | RETICAL AND PRACTICA | AL | | | | |
| GOAL: | This course is designed to equip | students with knowledge a | and skills of Ren | ewable Energy Te | echnolog | у | |
| GENEI | RAL OBJECTIVE 1.0: Unders | stand Basic Concepts of Ren | newable Energy | Technology | | | |
| THEOR | ETICAL CONTENT | | | PRACTICAL C | ONTEN | Γ | |
| Week | Specific Learning Outcome | Teacher's Activities | Resources | Specific Learnin Outcome | ng | Teacher's Activities | Resources |
| 1-2 | 1.1 Explain renewable energy technologies. | Explain renewable energy technologies. | Textbook Journal PC | Identify kinds of renewable energ technologies. | f ;y | Guide students to: Identify different | Video Clips |
| | 1.2 Explain the history of renewable energy technologies. | Explain the history of renewable energy technologies. | Marker Marker Board Internet | | | renewable energy technologies | |
| | 1.3 Describe types of renewable energy technologies. | Explain types of renewable energy technologies. | | | | | |
| | 1.4 Explain criteria for developing and using renewable technologies. | Explain criteria for developing and using renewable technologies. | | | | | |







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







| | 2.8 Explain concentrating solar power technologies concept. | Explain photovoltaic cells and solar thermal system Explain concentrating solar power technologies concept. | | EDUCA | | |
|-----|---|--|--|---|---|---|
| 6-8 | 3.1 Explain wind energy3.2 Describe factors that affect harnessing wind energy. | Explain wind energy Discuss factors that affect harnessing wind | Textbook Journal PC Projector Marker | Identify the wind Turbine Identify horizontal and vertical axis machines | Guide students to: Identify the wind Turbine | Wind turbine demonstratio n module, Anemometer Multimeter |
| | 3.3 Explain kinetic energy.3.4 Explain power generation in the wind turbine.3.5 Explain horizontal and | Explain kinetic energy. Explain power generation in the wind turbine | Marker Board Internet | Measure wind turbine energy generation | Identify horizontal and vertical axis machines Measure wind turbine energy generation | V1deos |
| | vertical axis turbine3.6 Explain wind turbine performance3.7 Explain wind turbine energy production | Explain horizontal and vertical axis turbine Explain wind turbine performance | | | | |







| | 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 | | EDUCA | |
|---------|--|--|---|-------|--|
| General | Objective 4 0:Understand Geoth | Discuss the advantages and disadvantages of wind energy. | ergy Technology | | |
| 9-10 | 4.1 Explain geothermal | Explain geothermal | Textbook | | |
| | system & their | system & their | Journal | | |
| | characteristics. | characteristics. | PC | | |
| | 4.2 Explain types of geothermal energy. | Explain types of geothermal energy. | Projector Marker Marker Board Internet | | |
| | 4.3 Explain: | | | | |
| | • Solar thermal | Explain: | | | |
| | • Geothermal | Color the march | | | |
| | • Heat pumps | • Solar thermal | | | |
| | 4.4 Explain the generation of | GeothermanHeat pumps | | | |
| | hydroelectric energy. | Explain the generation of | | | |
| | | hydroelectric energy. | | | |
| | N Y | - • | | | |







| | 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 | | CALEDUCA | | |
|---------|--|--|--|---|---|-------------|
| General | Objective 5.0: Know Biomass 7 | 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 gasification5.8 Outline the advantages and disadvantages of biofuels | Explain the utilization of biogas Explain Biomass gasification | | EDUCA | 101 | |
|---------|--|--|-------|-------|-----|--|
| | | Discuss the advantages and disadvantages of | | | | |
| | | biofuels | | | | |
| General | Objective 6.0: Understand Othe | r Renewable Energy Techn | ology | U' | | |
| 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. | 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 Hydrogen energy in relation to: • Principle of Fuel Cells | | | | |









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 | Course Code: RET 213 | Contact Hours: 2 | | | | |
|---|----------------------|------------------------|--|--|--|--|
| Renewable Energy | 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







| PROG | PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY | | | | | | |
|-------|--|---|------------------------------------|-----------------------------|------------------------|------------|--|
| COUR | SE TITLE: RESEARCH | COURSE CODE: RET 2 | 213 | | Contact Hours: 2 | | |
| METH | ODOLOGY IN RE | Credit Unit: 2 | | | Theoretical: 1 | | |
| Year: | II Semester: I | Pre-requisite: | | | Practical: 1 | | |
| COUR | SE SPECIFICATION: THEOF | RETICAL AND PRACTICA | AL | 4 | | | |
| GOAL | : This course is designed to acqu | aint the students with the k | nowledge and sk | ills on Research M | Iethodology in Renewal | ole Energy | |
| GENE | RAL OBJECTIVE 1.0: Unders | stand the Basic Concepts of | Research Metho | odology | | | |
| THEOF | RETICAL CONTENT | | | PRACTICAL C | ONTENT | | |
| Week | Specific Learning Outcome | Teacher's Activities | Resources | Specific Learnin Outcome | g Teacher's Activities | Resources | |
| 1-2 | 1.1 Define Research | Explain Research | Textbooks, Lecture notes, | | | | |
| | 1.2 Describe research objectives | Explain research objectives | Journals Marker Marker Board | | | | |
| | 1.3 Describe research motivation. | Explain research motivation. | PC Projector Internet | | | | |
| | 1.4 Explain the following research approach; a) Descriptive Research vs. Analytical Research b) Applied Research vs. Fundamental Research c) Quantitative vs. Qualitative | Explain the following research approach; Descriptive Research vs. Analytical Research Applied Research vs. Fundamental Research Quantitative vs. Qualitative | | | | | |







| | d) Conceptual vs. Experimental (or Empirical) e) Research Mathodology yergys | Conceptual vs. Experimental (or Empirical) Research | | | | |
|---------|---|--|----------------------------|-------------------|---|---------|
| | Research Methods | versus Research | | | | |
| | | Methods | | | | |
| | 1.5 Explain the significance | | | | | |
| | of research | Explain the significance | | | | |
| | 1.6 Describe the research | of research | | \mathcal{O}^{+} | | |
| | process | Discuss the research | | | | |
| | 1.7 Explain the concept of | process | | | | |
| | basic and applied research | Discuss the concept of | | | | |
| | processes | basic and applied | | | | |
| | 1.8 Explain the criteria for | research processes | | | | |
| | good research | Explain the criteria for | | | | |
| | good research. | good research. | | | | |
| General | Objective 2.0: Understand the c | oncept of Engineering Rese | earch | | Γ | |
| 3-4 | 2.1 Define engineering | Explain engineering | Textbooks, | | | |
| | research. | research. | Lecture notes, Journals | | | |
| | 2.2 Explain the importance | Explain the importance | Marker | | | |
| | of research in engineering | of research in | Marker Board | | | |
| | context | engineering research. | PC | | | |
| | | | Projector | | | |
| | 2.3 Explain engineering research process | Explain engineering research process | Internet | | | |















| | | Discuss conclusive proof | | | | |
|---------|---|---|---------------|----|---|--|
| Ganaral | Objective 3 0: Understand Liter | in engineering research. | | | | |
| General | Objective 3.0: Onderstand Liter | ature search and review | Γ | | | |
| 5-7 | 3.1 Describe archival | Explain archival | Textbooks | CX | 7 | |
| | literature | literature | Lecture notes | | | |
| | | | Journals | | | |
| | 3.2 Explain literature search | Explain literature search | Marker | | | |
| | | | Marker Board | | | |
| | 3.3 Explain Literature Review | Explain Literature | PC | | | |
| | Process | Review Process | Projector | | | |
| | | | Internet | | | |
| | 3.4 Describe the concept of | Describe the concept of | | | | |
| | Literature review | Literature review | | | | |
| | | | | | | |
| | 3.5 Explain Literature Review Process | Review Process | | | | |
| | 3.6 Explain types of Review Articles | Explain types of Review Articles | | | | |
| | 3.7 Explain types of publications | Explain types of publications | | | | |
| | 3.8 Describe the measure of research impact | Describe the measure of research impact | | | | |
| General | Objective 4.0: Understand the b | asic concepts of data collect | ction | | • | |
| | 4.1 Define data collection | Explain data collection | Textbooks | | | |
| 8-9 | | * | Lecture notes | | | |
| | 4.2 Describe the following: | Describe the following: | Journals | | | |
| | | • Primary and | Marker | | | |
| | | secondary data | Marker Board | | | |







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







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| 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 epare a practical ovrt that outlines the puired sections of the port: 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 |
|--|---|---|--|--|





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







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.





MALBORDORTHOMMENT



INTRODUCTION TO RENEWABLE ENERGY APPLICATION PACKAGES

PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY

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

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ONALBOARD

2.0 Know the renewable energy applications packages

3.0 Know basic concept of Soft Computing in Renewable Energy







| PROGI COURS | RAMME: NATIONAL DIPLO | MA IN RENEWARBLE E COURSE CODE: RET 2 | NERGY TECH | INOLOGY | Contact | Hours: 2 | NIGERI |
|----------------|---|---|--|--------------------------------------|-----------------|---|-------------------------|
| ENERG PACKA | Y APPLICATION | Credit Unit: 2 | | | Theoret | ical: 1 | |
| Year: | II Semester: I | Pre-requisite: | | | Practica | l: 1 | |
| COURS | SE SPECIFICATION: THEOR | ETICAL AND PRACTICAL | | | | | |
| GOAL: | This course is designed to acqua | int students with knowledge | and skills of sof | ft computing in Re | newable | Energy | |
| GENER | AL OBJECTIVE 1.0: Know Re | enewable Energy application | i packages | | | | |
| THEOR | ETICAL CONTENT | | | PRACTICAL CO | JNTENI | ` | |
| Week | Specific Learning Outcome | Teacher's Activities | Resources | Specific Learnin Outcome | g | Teacher's Activities | Resources |
| 1-5 | 1.1 Explain the concept of software Application in RE | Explain the concept of software Application in RE | Textbook Journal PC Projector | Identify the softwapplication syste | vare m in RE | Guide the students to: Identify the software application | RE Software application |
| | 1.2 Explain types of Software Application in RE | Explain types of Software Application in RE | Marker Markerboard Internet | | | system in RE | |
| | 1.3 Explain areas of use of energy software application in RE | Explain areas of use of energy soft application in RE | Internet | | | | |
| | | | | | | | |
| General | Objective 2.0: Know the renew | • able energy applications p | ackages | 1 | | | |
| 6-10 | 2.1 Define application packages | Explain application packages | Textbook Journal | Install the follow application packs | ring RE ages | Guide students to: | RETScreen |
| | | | PC Projector | RETScre | en | Install the following RE application | 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 | 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 conc | ept of Soft Computing in I | Renewable Ener | ·gy | | |
| 11-15 | 3.1 Define Soft Computing3.2 Define ArtificialIntelligence (AI) | Explain Soft Computing Explain Artificial Intelligence (AI) | Textbook Journal PC Projector Marker | Forecast Solar Power using Microsoft excel | Guide students to: Forecast Solar Power using Microsoft excel | Microsoft Application package |
| | | | Markerboard | | | |















| | | Explain projects base learning. | | N. N | | |
|---|--|---------------------------------|--|--|--|--|
| 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 RENEWABI | LE ENERGY | | | | | | |
|--|--|-----------------------|--|--|--|--|--|
| COURSE TITLE: RENEWABLE ENERGY | Course Code: RET 221 | Contact Hours: | | | | | |
| INSTALLATION AND MAINTENANCE II | Credit Unit: 3 | Theoretical: 1 | | | | | |
| Year: II Semester: II | Pre-requisite: | Practical: 2Hour/week | | | | | |
| GOAL: This course is designed to equip the students wit | 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 Photovolta | nic (PV) Systems | | | | | | |
| 4.0 Know the Installation Procedures in Solar Thermal Sy | ystems | | | | | | |
| 5.0 Know the Installation Procedures in Wind Energy Sy | vstems | | | | | | |
| 6.0 Know the Installation Procedures in Hydropower Sys | stems: | | | | | | |
| 7.0 Know the Installation Procedures in Biomass Energy Systems | | | | | | | |
| 8.0 Know RE Systems Troubleshooting | | | | | | | |
| 9.0 Know Preventive Maintenance Strategies | | | | | | | |







R

| tact Hours: 3 | |
|---|---|
| pretical: 1 | |
| tical: 2 | |
| | |
| enewable Energy Syster | n. |
| | |
| ENT | |
| Teacher's Activities | Resources |
| on Guide students to: Demonstrate installation layout Simulate Installation of a simple Renewable Energy system | Process flow-chart Simulation software PC system Internet |
| | |
| Guide students to: | |
| Install a simple RE | Regulation |
| Electrical system | 8 |
| on Apply relevant | |
| | tact Hours: 3 pretical: 1 tical: 2 tenewable Energy System ENT Teacher's Activities ion Guide students to: Demonstrate installation layout Simulate Installation of a simple Renewable Energy system Guide students to: Install a simple RE Electrical system ion Apply relevant |















| Genera 5-6 | l Objective 3.0: Know the Instal | equipment (PPE) requirements. • Material handling and storage. lation Procedures in Solar F Explain the steps in | Photovoltaic (PV Textbooks | 7) Systems | Guide students to: | Tool kits |
|---------------|---|---|---|--|--|---|
| | 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 | 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 | lectures note, Journal PC Projector Marker Markerboard internet | 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 | Demonstrate the installation techniques for: Panels mounting Wiring Charge controller Inverter Battery storage Protective devices Meter connection Grid connection Install and maintain PV systems | 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 ElectricalConnect ions Battery Maintenance ProfessionallInsp ections | | | Demonstrate PV System components sizing Demonstrate safety practices in PV System Installation | |
|---------|---|---|---|--|---|---|
| General | Objective 4.0: Know the Instal | lation Procedures in Solar T | Thermal Systems | 8 | | |
| 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 Storage tanks Control Units Grid connector Storage tanks Control Units Grid connector Storage tanks Grid connector Planning and preparations Roof Assessment Orientation and angles System sizing Component selection Permit and regulation Soor Assessment Component selection Roof mounting ground mounting(star dy fundation clearance) Connecting the system Piping tools Solar thermal collectors Heat exchangers Storage fund Grid connector Storage fund ground mounting(star dy fundation clearance) Storage Storage foundatio n clearance forid connector | | | | | |
|--|--|--|--|--|--|
| | 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(stur dy 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 foundatio n ,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 | 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 | Connecting the | | Demonstrate solar | Install and maintain | |
|-------------------------------|-------------------------------|--------|--------------------|----------------------|--|
| control(circulation, | system | | thermal System | solar thermal | |
| control) | • Piping (heat | | components sizing | systems | |
| 4.4 Describe safety measures: | transfer fluid, | | \sim | | |
| Pressure release | insulation,) | | Demonstrate safety | Demonstrate solar | |
| valve(PRV) | • Storage | | practices in solar | thermal System | |
| Thermostatic | tank(location, | | thermal System | components sizing | |
| Mixing Valve | insulation) | | Installation | | |
| (TMV) | • pump and | | | Demonstrate safety | |
| • Expansion vessel | control(circul | | | practices in solar | |
| • Sensor wires | ation, control) | | | thermal System | |
| 4.5 Explain testing and | Explain safety measures: | | | Installation | |
| commissioning | • Pressure | | | | |
| Leak testing | release | ĊY | | | |
| • system start up | valve(PRV) | | | | |
| • performance | • Thermostatic | | | | |
| monitoring | Mixing | × · | | | |
| 4.6 Explain the importance | Valve | | | | |
| of following: | (TMV) | , , | | | |
| • Measuring tape | Expansion | | | | |
| • Inspection tools | vessel | | | | |
| • Electrical system | • Sensor wires | | | | |
| evaluation tools | Explain testing and | | | | |
| • Safety equipment | commissioning | | | | |
| • Piping tools | • Leak testing | | | | |
| Roofing tools | • system start | | | | |
| Welding equipment | up | | | | |
| | • performance | | | | |
| | monitoring | | | | |
| | | | | | |







| | | Explain the importance of following: Measuring tape Inspection tools Electrical system evaluation tools Safety equipment Piping tools Roofing tools Welding equipment | | CALEDUCE | | |
|--------------------------|---|--|---|--|--|---|
| General C | Objective 5.0: Understand the I | Installation Procedures in W | Vind Energy Sys | stems | | |
| 10 5 e 5 v v | 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 |















| | | | | ALEDICA | safety procedures 5.5 maintenance preventive maintenanc e corrective maintenanc e safety | |
|---------|--------------------------------|-----------------------------|----------------|---------------------------|--|--------------|
| General | Objective 6.0. Know the Instal | llation Procedures in Hydro | nower Systems | | procedures | |
| | | | | | | X 7°1 |
| 11-12 | o.1 Explain hydropower | Explain hydropower | 1 extbooks, | Simulate the installation | Guide student to: | video |
| | energy system | energy system | lectures note, | of hydropower energy | Simulate the | clips |
| | 6.2 Explain civil work | | Journal | system | installation of | Relevant |
| | | Explain civil work | PC | | hydropower energy | Software |
| | 6.3 Explain penstock | | Projector | | system | |
| | installation | Explain penstock | Marker | | | |
| | | installation | Markerboard | | | |
| | 6.4 Explain valve installation | | internet | | | |
| | * | Explain valve | | | | |
| | 6.5 Explain power house | installation | | | | |
| | construction | | | | | |
| | | Explain power house | | | | |
| | 6.6 Explain hydro turbine | construction | | | | |
| | bydro generator or turbing | construction | | | | |
| | appareter group installation | Evaloin hydro turbing | | | | |
| | generator group installation | Explain nydro turbine, | | | | |
| | | nydro-generator or | | | | |
| | 6. / Explain drive system | turbine generator group | | | | |
| | installation | installation | | | | |
| | | | | | | |
| | | | | | | |







| | 6.8 Describe wiring, switch | Explain drive system | | | | |
|---------|---------------------------------|----------------------------|-----------------|---------------------------|-----------------------|-------|
| | gear and protection | installation | | | | |
| | installation | | | | | |
| | | Describe wiring, switch | | ĊX | | |
| | 6.9 Explain controls and | gear and protection | | | | |
| | auxiliary installations | installation | | | | |
| | | | | | | |
| | 6.10 Explain testing and | Explain controls and | | | | |
| | commissioning | auxiliary installations | | | | |
| | | Explain testing and | | | | |
| | | commissioning | | | | |
| General | Objective 7.0: know the Install | ation Procedures in Riomas | s Energy System | ns | | |
| 13 | 7 1 Explain biomass energy | Explain biomass energy | Textbooks | Simulate the installation | Guide student to: | Video |
| 10 | system | system | lectures note. | of Biomass energy | Simulate the | clips |
| | <i></i> | | Journal | system | installation of | •nps |
| | 7.2 List the components of | List the components of | PC | | Biomass energy | |
| | Biomass system: | Biomass system: | Projector | | system | |
| | Combustion chamber | Combustion | Marker | | • | |
| | • Boiler | chamber | Markerboard | | | |
| | • steam | • Boiler | internet | | | |
| | • Electricity generator | • steam | | | | |
| | • Biodigester | • Electricity | | | | |
| | • Trans-esterification | generator | | | | |
| | reactor | Biodigester | | | | |
| | • Fermenter | • Trans- | | | | |
| | × 1 | esterification | | | | |
| | 7.3 Explain Installation and | reactor | | | | |
| | Connection of: | • Fermenter | | | | |
| | • Boiler | | | | | |
| | Conveying System | Explain Installation and | | | | |
| | | Connection of: | | | | |







| | 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 Safety System Safety System: Pre- Commissioning Commissioning Commissioning Training | CH | CALEDUCE | | |
|---------|---|--|---|--|--|-------------------------|
| General | Objective 8.0 Know RE Syster | ns Troubleshooting | | | 1 | |
| 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 DE Sector Evidence | 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 | 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 | e Maintenance Strategies | | | | |
|---------|---|---|--|-------------------------------|-----------------------|------------|
| 15 | 1.1 Explain planning and scheduling of preventive maintenance of RE system | Explain planning and scheduling of preventive maintenance of RE system | Marker board, Marker, Textbook, Lecture note | JUA A | | |
| | 1.2 Explain predictive maintenance implementation techniques. | Explain predictive maintenance implementation techniques. | | CALEN | | |
| | 1.3 Explain asset management and life cycle planning. | Explain asset management and life cycle planning. | CH | | | |
| | 1.4 Explain energy management in RE systems. | Explain energy management in RE systems. | | | | |
| ASSES | 1.5 Explain the improvements in maintenance practices. | Explain the improvements in maintenance practices. | 1 be awarded 60 | 10% of the total score. The s | and of the Somester F | vamination |
| HOOLO | | smem, lesis and quizzes wi | ii be awalued bu | | and of the Semester E | vanimation |

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 Course Code: RET: 222 Contact Hours: 3 TECHNOLOGY AND APPLICATION II Theoretical: 1 Credit Unit: 3 Semester: II Year: 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







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| PROGRAMME: NATI | ONAL DIPLO | DMA RENEWABLE ENE | CRGY | | | | |
|--|--|--|---|--|-----------------------|--|---|
| COURSE TITLE: REN | EWABLE | Course Code: RET: 222 | | | Contact | Hours: 3 | |
| ENERGY TECHNOLOG | GY AND | Credit Unit: 3 | | | Theoret | ical: 1 | |
| Year: II Semester: II | | Pre-requisite: | | | Practica | ll: 2Hour/week | |
| COURSE SPECIFICAT | FION : THEOF | RETICAL AND PRACTICA | AL | | | | |
| GOAL: This course is de | signed to acqua | aint students with the know | ledge and skills | of Renewable Ener | rgy tech | nology and application | ons |
| GENERAL OBJECTIV | E 1.0: Know S | Solar Photovoltaic Technolo | ogy | | | | |
| THEORETICAL CONTI | ENT | | | PRACTICAL CO | DNTEN | Г | |
| Week Specific Learnin | ng Outcome | Teacher's Activities | Resources | Specific Learning Outcome | 5 | Teacher's Activities | Resources |
| 1-2 1.1 Explain the Solar Photosystems: Grid Off- Stan 1.2 Explain the demerits of PV 1.3 Explain the the solar PV system rating terms of the system ratio of the system rating terms of term | following voltaic connected grid d-alone merits and cells operation of stem following PV rms: l Test ons (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 Parallel Install the roof top PV system | 7 s and p solar | Guide students to: Connect Solar PV Batteries in series and Parallel Install the roof top solar PV system | Batteries Solar RE system Ladder |















| 3-5 | 2.1 Explain the concept of solar thermal technology2.2 Explain solar thermal | Explain the concept of solar thermal technology Explain solar thermal | Textbooks, lectures note, Journal PC Projector | Identify the following collectors: • Flat plate • Parabolic • Parabolic dish | Guide students to: Identify the following collectors: • Flat plate | Solar dryer Demonstratio n videos |
|-----|---|--|--|--|--|---|
| | system classification 2.3 Explain Concentrated | system classification Explain Concentrated Solar Power (CSP) | Marker Markerboard internet | Solar tower | Parabolic Parabolic dish | |
| | Solar Power (CSP) system. | system. | | Identify different solar dryers. | • Solar tower | |
| | 2.4 Describe the following collectors:Elat plate | Discuss the following collectors: | | | Identify different solar dryers. | |
| | ParabolicParabolic dish | Flat plate Parabolic Parabolic dish | (B) | | | |
| | Solar tower 2.5 Define solar dryer | • Solar tower | | | | |
| | 2.5 Define solar dryer | Explain solar dryer | | | | |
| | 2.6 Explain the Classification, construction, working of solar dryers | Explain the Classification, construction, working of | | | | |
| | 2.7 Outline the applications for commercial system, | solar dryers | | | | |
| | agro-products and domestic system. | Outline the applications for commercial system, agro-products and domestic system | | | | |







| General Objective 3.0: Know Wind Energy Technology | | | | | | |
|--|---|--|---|--|--|--------------------------|
| 6-7 | 3.1 Explain the concept of wind energy technology. 7 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 | 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, execution of the construction of the construction. | 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 | Demonstratio n videos |
| | specifications Small Wind power plant3.4 Describe the components of the small wind power plant | operation principle and specifications Small Wind power plant Explain the components of the small wind power | | | | |
| | 3.5 Explain the construction, working and specifications of large wind power plant3.6 Describe the components of the large wind power plant | Explain the construction, working and specifications of large wind power plant | | | | |







| | 3.7 Describe the procedure to | Explain the components | | | | |
|---------|--------------------------------|--------------------------|----------------|----|---|--|
| | undertake routine | of the large wind power | | | | |
| | maintenance of small | plant | | | | |
| | wind turbines. | 1 | | | Y | |
| | | | | | | |
| | 3.8 Describe the procedure to | Discuss the procedure to | | | | |
| | s.o Describe the procedure to | undertake routine | | | | |
| | | maintenance of small | | | | |
| | turbines. | wind turbines. | | | | |
| | | | | | | |
| | | | | CY | | |
| | | Discuss the procedure to | \sim | | | |
| | | maintain large wind | | × | | |
| | | turbines. | | | | |
| General | Objective 4.0:Understand Micro | o Hydro Power Technology | | | 1 | |
| | 4.1 Explain the concept of | Explain the concept of | Textbooks, | | | |
| 8-10 | micro hydro power | micro hydro power | lectures note, | | | |
| | technology. | technology. | Journal | | | |
| | | | PC | | | |
| | 4.2 Explain the construction | | Projector | | | |
| | and working of specified | Explain the construction | Marker | | | |
| | type of micro hydro | and working of specified | Markerboard | | | |
| | nower systems | type of micro hydro | internet | | | |
| | power systems. | power systems. | | | | |
| | 1.2 List the various | | | | | |
| | 4.5 List the valious | | | | | |
| | components in a given | Explain the various | | | | |
| | micro hydro power plant | components in a given | | | | |
| | | micro hydro power plant | | | | |
| | 4.4 Explain the selection of | | | | | |
| | micro-hydro systems. | | | | | |
| | | | | | | |







| 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 | | A EDUCA | | |
|--|---|---|--|--|-----------------------------------|
| Conorol Objective 5 0: Know Discover | system. | | | | <u> </u> |
| General Objective 5.0: Know Bio-ener11-135.1 Explain the classification of biofuels.5.2 Explain technologies for the following power plants: • Biomass • Bio-gas plants • Bio-diesel5.3 Explain the following in relation to small power plant: • Layout • Construction • Mode of operation | gy Technology 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 | Demonstratio n 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 | | | | |
|---|---|---|--|--|--|--|
| | | Discuss the installation and maintenance procedure for Biogas plant. | | | | |
| eneral Objective 6.0: Know Kenewable Energy Hydrid Technology | | | | | | |







| 14-15 | 6.1 Explain the concept of | Explain the concept of | Textbooks, | Identify the following | Guide students to: | Video clips | |
|-------|------------------------------|--------------------------|----------------|----------------------------------|--------------------|-------------|--|
| | hybrid renewable energy | hybrid renewable energy | lectures note, | hybrid power plants: | Identify the | | |
| | technology | technology | Journal | • Wind- Solar | tollowing hybrid | | |
| | | | PC | Wind-Hydro | power plants: | | |
| | 6.2 Explain the construction | | Projector | • Wind-Biogas | Wind- Solar | | |
| | and specification of | Explain the construction | Marker | Solar-Biogas | • Wind- | | |
| | following hybrid systems: | and specification of | Markerboard | Solui Diogus | Hydro | | |
| | • Wind-Solar | following hybrid | internet | | • Wind- | | |
| | • Wind-Hydro | systems: | | | Biogas | | |
| | Wind-Riogas | Wind-Solar | | | • Solar- | | |
| | - Soler Diogas | Wind Hydro | Á | | Biogas | | |
| | • Solar-Diogas | • Wind Dieses | | | 210540 | | |
| | 0.5 Explain power output of | • wind-Biogas | | | | | |
| | nyoria system. | • Solar-Biogas | | | | | |
| | 6.4 Europein how to process | Explain power output of | | | | | |
| | 0.4 Explain now to prepare | hybrid system. | Y | | | | |
| | layouts of hybrid power | | | | | | |
| | system. | | | | | | |
| | | Explain how to prepare | | | | | |
| | 6.5 Explain the operating | layouts of hybrid power | | | | | |
| | procedure of wind-solar | system. | | | | | |
| | PV hybrid system. | hr | | | | | |
| | 6.6 Outline the applications | Explain the operating | | | | | |
| | of wind-solar PV hybrid | procedure of wind-solar | | | | | |
| | system | PV hybrid system. | | | | | |
| | system. | | | | | | |
| | 6.7 Describe the performance | | | | | | |
| | parameters of Wind Solar | Outline the applications | | | | | |
| | DV hybrid system | of wind-solar PV hybrid | | | | | |
| | r v nybrid system. | system. | | | | | |
| | | | | | | | |






| 6.8 Describe the procedure to test the performance of wind-solar PV hybrid system. | Discuss the performance parameters of Wind- Solar PV hybrid system. | | | | |
|---|--|----------------|------------------------------|-----------------------|----------------|
| 6.9 Explain the installation- procedure for wind-solar PV hybrid system 6.10 Explain the Trends in | Discuss the procedure to test the performance of wind-solar PV hybrid system. | | ALEDUC | | |
| hybrid renewable energy | | | | | |
| | Explain the installation- | | | | |
| | procedure for wind-solar | | | | |
| | PV hybrid system | CB / | | | |
| | Explain the Trends in | | | | |
| | hybrid renewable energy | | | | |
| ASSESSMENT: The continuous assess | ment, tests and quizzes will | be awarded 609 | % of the total score. The en | nd of the Semester Ex | amination will |
| 1 = 1 = 1 = 1 = 1 = 1 = 1 = 1 = 1 = 1 = | tal agona | | | | |

make up for the remaining 40% of the total score.







EMERGING TECHNOLOGIES IN RENEWABLE ENERGY

| PROGRAMME: NATIONAL DIPLOMA RENEWAR | BLE ENERGY | |
|--|-----------------------------------|--------------------|
| COURSE TITLE: EMERGING TECHNOLOGIES IN | Course Code: RET 223 | Contact Hours: |
| RENEWABLE ENERGY | Credit Unit: 2 | Theoretical: 2 |
| Year: II Semester: II | Pre-requisite: | Practical: Nil |
| GOAL: This course is designed to acquaint the student w | vith 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 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 Denouvable Energy Technologies | le Energy Technologies | |
| R | DEOR | |
| ALBOIN | | |
| ALA HOL | | |
| | 110 | |
| NULUDE | 110 | |





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| PROGI | RAMME: NATIONAL DIPLO | DMA RENEWABLE ENE | RGY TECHN | OLOGY | | 0 | |
|----------------|--|--|---|-----------------------------|---------------|---------------------|-----------|
| COURS | SE TITLE: EMERGING | Course Code: RET 223 | | | Contact Hou | urs: | |
| TECHN ENERG | OLOGIES IN RENEWABLE | Credit Unit: 2 | | | Theoretical: | 2 | |
| Year: | II Semester: II | Pre-requisite: | | | Practical: Ni | il | |
| COURS | SE SPECIFICATION: THEOF | RETICAL AND PRACTICA | AL | |) | | |
| GOAL: | This course is designed to acqu | aint the student with the kn | owledge of eme | erging technologie | es in RE | | |
| GENEF | RAL OBJECTIVE 1.0: Unders | stand the Basic Concept of I | Emerging Renev | wable Energy Tec | hnologies | | |
| THEOR | ETICAL CONTENT | | | PRACTICAL C | CONTENT | | |
| Week | Specific Learning Outcome | Teacher's Activities | Resources | Specific Learnin Outcome | ng Tea Act | acher's tivities | 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 | 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 | Textbooks, lectures note, Journal PC Projector Marker Markerboard internet | | | | |
| | 1.4 Explain renewable energy for future generations 1.5 Explain the following emerging technologies Floating Solar Farms | Explain the following emerging technologies • Floating Solar Farms | | | | | |







| Compared | 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 | | CALEDUCA | |
|----------|--|--|---|----------|--|
| 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 | | ALEDUCA | |
|---------|---|--|---|---------|--|
| General | Objective 3.0: Understand Eme | rging Wind Power Technol | ogies | | |
| 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 Emer | ging Energy Storage Techr | ologies | | |
| 9-10 | 4.1 Explain the emerging concepts in energy storage 4.2 Explain the following emerging storage technologies: | 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 | | |







| r | | ſ | | | |
|---------|---|---|-----------------|----------|--|
| | • Flow Batteries | • 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 | 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 | TECH | CALEDUCA | |
| | 4.6 Explain the flywheel | Explain the flywheel | | | |
| | energy storage | energy storage | | | |
| General | Objective 5.0: Understand Smat | rt Grid and Grid Integration | | | |
| 11-12 | 5.1 Define Smart grid | Explain Smart grid | Textbooks, | | |
| | | | lectures note, | | |
| | 5.2 Outline the functions of | Explain the functions of | Journal | | |
| | smart grid | smart grid | PC Projector | | |
| | | Explain the traditional | Marker | | |
| | 5.3 Explain the traditional | power grid and smart | Markerboard | | |
| | power grid and smart grid | grid | internet | | |
| | 5.4 Explain smart grid and distributed energy system | Explain smart grid and distributed energy | | | |
| | | system | | | |







| | 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 | | CALEDUCA | |
|---------|--|--|---|-----------|--|
| General | Objective 6.0: Understand Eme | rging Renewable Energy Te | echnologies in T | Fransport | |
| 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 | 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 assess will make up for the remaining 60% of the | he total score. | The awarded 40% of the total score. The end of the So | |
| INCLUDE KNOWLEDGE PLATFORM ON INCLUSIVE DEVELOPMENT POLICIES | | 116 | |







ENGINEERING PROJECT MANAGEMENT

PROGRAMME: NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY

MAL BOMPL

| COURSE TITLE: ENGINEERING PROJECT | Course Code: RET 224 | Contact Hours: 2 |
|--|-------------------------------------|--------------------------------|
| MANAGEMENT | 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 Renewal | ble 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







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| PROG | RAMME: NATIONAL DIPLO | DMA RENEWABLE ENE | RGY TECHNO | LOGY | | | |
|--|---|--|---|---------------------------|----------|-------------------------|------------|
| COURSE TITLE: ENGINEERING COURSE CODE: RET 224 | | | 224 | | Contac | t Hours: 2 | |
| PROJE | CT MANAGEMENT | Credit Unit: 2 | | | Theore | tical: 2 | |
| Year: | II Semester: II | Pre-requisite: | | <u> </u> | Practic | al: | |
| COUR | SE SPECIFICATION: THEOR | RETICAL AND PRACTICA | AL | | | | |
| GOAL: | This course is designed to equip | the student with the know | ledge and skills o | f Renewable En | ergy eng | ineering project n | nanagement |
| GENE | RAL OBJECTIVE 1.0: Under | stand the basic concepts of | project manageme | ent | <u></u> | | |
| THEOF | RETICAL CONTENT | | | PRACTICAL | CONTE | NT | |
| Week | Specific Learning Outcome | Teacher's Activities | Resources | Specific Learn Outcome | ing | 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 management1.6 Explain the challenges in engineering project | Explain programmes and portfolio management Discuss the challenges in engineering project management | | 10 | |
|---------|---|--|---------------|----|--|
| | management | | | | |
| General | Objective 2.0: Understand Engi | neering Project Organization | n | | |
| | 2.1 Explain the basic | Explain the basic | Textbooks, | | |
| 3-5 | concepts of Project | concepts of Project | Lecture notes | | |
| | Organization | Organization | Journals | | |
| | | | Marker | | |
| | 2.2 Describe the elements of | Explain the elements of a | Markerboard | | |
| | a strong project | strong project | PC | | |
| | organizational structure. | organizational structure. | internet | | |
| | | | Internet | | |
| | | Explain types of project | | | |
| | 2.3 Explain types of project | organizational structure | | | |
| | organizational structure in | in project management | | | |
| | project management | | | | |
| | | Discuss the functional | | | |
| | 2.4 Describe the functional | project organizational | | | |
| | project organizational | structure | | | |
| | structure | Explain team | | | |
| | | establishment within | | | |
| | 2.5 Explain team | project organizational | | | |
| | establishment within | structure | | | |
| | project organizational | | | | |
| | structure | Discuss factors | | | |
| | | influencing project | | | |







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







| General | Objective 4.0: Know Project fir | nance and contract managem | nent | | |
|---------|--|--|-------------------------------|-------|--|
| | 4.1 Define; | Explain; | Recommended | | |
| 9-11 | • Project finance | • Project finance | text books, | | |
| | Contract management | Contract | Lecture notes, | C Y | |
| | 4.2 Explain types and sources of capital for engineering project financing | management Explain types and sources of capital for engineering project financing | and materials and internet | ALEDU | |
| | 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 | 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 | THOM | | |
| | 4.6 Describe stages for evaluation of engineering contracts | Explain stages for evaluation of engineering contracts | | | |







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







| 5.6 Explain different forms of | Explain the following: | | | | |
|----------------------------------|-----------------------------------|----------------|----------------------------|-----------------------|-----------|
| tender-bill of quantities | • Schedules of rates | | | | |
| and materials. | • Tender-standing | | | Y | |
| | offer | | \sim | | |
| 5.7 Explain the following: | | | | | |
| 5.7 Explain the following. | • Simple otter | | | | |
| • Schedules of rates | Tendering and | | | | |
| Tender-standing offer | contract formation. | | | | |
| • Simple offer | | | | | |
| • Tendering and contract | Explain types of tender- | | | | |
| formation | standing offer | | | | |
| Tormation. | summing one | | | | |
| | Describe tendering | | | | |
| 5.8 Explain types of tender- | arrangements | | | | |
| standing offer | arrangements | ĊXY | | | |
| | | | | | |
| 5.9 Describe tendering | | | | | |
| arrangements | | | | | |
| | | | | | |
| SSESSMENT. The continuous assess | ment tests and quizzes will | be awarded 40% | of the total score. The or | nd of the Somester Ex | omination |

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







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| PROG | RAMME: NATIONAL DIPLO | MA RENEWABLE ENE | RGY TECHNO | OLOGY | | | |
|---------|--|--|---|-----------------------------|----------|-------------------------|-----------|
| COUR | SE TITLE : Engineering Ethics | COURSE CODE: RET 2 | 225 | | Contact | t Hours: 2 | |
| | | Credit Unit: 2 | | | Theoret | tical: 2 | |
| Year: | II Semester: II | Pre-requisite: | | | Practica | al: Nil | |
| COUR | SE SPECIFICATION: THEOF | RETICAL AND PRACTICA | AL | | | | |
| GOAL | : This course is designed to acqu | aint students with the know | ledge of engine | ering professional | l ethics | | |
| GENE | RAL OBJECTIVE 1.0: Unders | tand basic concept of Engin | eering Ethics | | | | |
| THEOF | RETICAL CONTENT | | | PRACTICAL C | ONTEN | Т | |
| Week | Specific Learning Outcome | Teacher's Activities | Resources | Specific Learnin Outcome | ng | 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 pri | nciples of ethics in renewa | able energy | Γ | | T | |
| 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. | | CALEDUCA | | |
|---------|---|--|---|----------|---|--|
| General | Objective 3.0: Understand the | social impacts of Renewa | ble 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 | 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 | Textbooks, Lecture notes, Journals Marker Marker Board PC Projector | | | |
| | FJeers | projects | | | | |
| General | Objective 4.0:Understand the | environmental impacts of | Renewable En | ergy | I | |
| 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. | depletion. Explain the concept of environmental impact assessment and mitigation. | Journals Marker Marker Board PC Projector | | |
|---------|---|---|---|-----|--|
| | 4.3 Explain the role of | | | | |
| | renewable energy in | Explain the role of | | | |
| | addressing climate | renewable energy in | | C Y | |
| | change. | change | | | |
| | 4.4 Explain the environmental | enange. | | | |
| | impacts of solar, wind, | | | | |
| | and hydro projects. | | | | |
| General | Objective 5.0: Understand the | Renewable Energy Profe | ssional ethics | | |
| 14-15 | 5.1 Explain technician's | Explain technician's | Textbooks, | | |
| | responsibility concerning | responsibility concerning | Lecture notes, | | |
| | renewable energy to the | renewable energy to the | Journals Marker | | |
| | public. | public. | Marker Board | | |
| | Explain the concepts of | Explain the concepts of | PC Drainator | | |
| | Confidentiality | Confidentiality | Projector | | |
| | Conflicts of interest | • Conflicts of | | | |
| | • Whistleblowing. | interest | | | |
| | TION | • Whistleblowing. | | | |







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|---------|-----------------------------------|------------------------------|-------------------|------------------------------|-----------------------|----------------|
| | 5.2 Explain the role of | Explain the role of | | | | |
| | technicians in promoting | technicians in promoting | | A | | |
| | sustainable practicas | sustainable practices | | | Y | |
| | sustainable practices. | sustamable practices. | | | 7 | |
| | | | | | | |
| | Enumerate ethical dilemmas | Enumerate ethical | | | | |
| | in renewable energy projects. | dilemmas in renewable | | | | |
| | | energy projects. | | | | |
| ASSES | SMENT: The continuous assess | ment, tests and quizzes will | be awarded 40 | % of the total score. The en | nd of the Semester Ex | amination will |
| make up | o for the remaining 60% of the to | otal score. | | | | |
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| | INCLUSIVE DEVELOFMENT FOLICIES | | | | | NBTI |
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INCLU



PRACTICAL MANUAL

| | PRACTICAL MANUAL |
|---------------------------|--|
| RET 311 | 1. Identify simple renewable energy |
| Introduction to Renewable | devices/systems: |
| Energy | • 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 | 1. Test solar energy |
| Energy Systems | 2. Plot the V L share staristics of solar call and |
| | 2. Flot the V-I characteristics of solar cell and determine the Fill Factor (FF) |
| | determine the Phil Pactor (11) |
| | 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 | 1. Identify the various sources to produce |
| Basic Chemistry for Renewable | biodiesel, bioethanol and biogas |
| Energy | 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 | 1. Detect the prevalent environmental conditions in |
| RENEWABLE ENERGY AND ENVIRONMENT | 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. |
| | A Dremone EIA and EIS for any true different |
| | 4. Prepare EIA and EIS for any two different |
| Introduction to Digital Electronics | 1 Demonstrate conversion from decimal and |
| EEC 112 | 1. Demonstrate conversion from decimal and |
| EEC 112 | |
| | 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 |
|---|
| adders, subtractors, 8. Design and implement adders and subtractors using logic gates |
| 8. Design and implement adders and subtractors using logic gates |
| 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 |
| |
| 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 flin flons |
| and counters |







| | | 1 |
|--------------------|---|---|
| | 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 | Y |
| RET 211 | 1. Identify Graphical symbols in installation of RE | |
| RENEWABLE ENERGY | system | |
| INSTALLATION AND | | |
| MAINTENANCE I | 2. Draft RE Symbols Using RE Software | |
| | 3. Produce wiring/connection diagram for RE | |
| | system | |
| | 4. Draw the wiring diagram of RE system | |
| | 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 | 1. Identify different kinds of renewable energy | |
| KEINEWABLE EINEKGY | technologies. | J |





| TECHNOLOGY AND | | |
|-------------------------|---|---|
| APPLICATION I | 2 Magura solar radiation | |
| | 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 | 1. Explore different aspects of report preparation | |
| RESEARCH METHODOLOGY IN | and presentation by | |
| RE | • Reading published information. | |
| ~ | • Carrying out the experiment. | |
| | • Collect and organize data from the experiment and the published information | |
| | Interpret the results | |
| | | J |







| | 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. | FIDUCATION |
|--|--|------------|
| RET 214 INTRODUCTION TO RENEWABLE ENERGY APPLICATION PACKAGES | Identify the software application system in RE Install the following RE application packages RETScreen System Advisor Model (SAM) Energy Plus OpenDSS Assess Solar installation site using RETScreen of rectifier outputs. Forecast Solar Power using Microsoft excel | |
| RET 221 RENEWABLE ENERGY INSTALLATION AND MAINTENANCE II | Demonstrate installation layout Simulate Installation of a simple Renewable Energy system Install a simple RE Electrical system Apply relevant safety standards and regulation | |







| | 4 |
|---|-----|
| 5. Demonstrate the installation techniques for: | 07 |
| Panels mountingWiring | |
| Charge controller | |
| Inverter Battamy store as | |
| Battery storage Protective devices | |
| Meter connection | , Y |
| Grid connection | Y |
| | |
| 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 | |
| Kooting tools Wolding againment | |
| • weiding equipment | |
| 10. Identify the components of wind turbine system: | |
| Rotor | |
| Nacelle | |





NBTE

| 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 | | | ~ |
|--|------------------|--|---|
| 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 | | • Tower | |
| 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 | | Generator | |
| 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 | | • Gear box | |
| 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 | | 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 | | | |
| 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 | | 11. Demonstrate wind turbine mounting and | |
| 12. Simulate the installation of hydropower energy system 13. Simulate the installation of Biomass energy system 14. Troubleshoot simple faults in RE system | | connection procedure | |
| system 13. Simulate the installation of Biomass energy system 14. Troubleshoot simple faults in RE system | | 12. Simulate the installation of hydropower energy | |
| 13. Simulate the installation of Biomass energy system 14. Troubleshoot simple faults in RE system | | system | 7 |
| 13. Simulate the instantation of Biomass energy system 14. Troubleshoot simple faults in RE system | | 12 Simulate the installation of Diamore energy | |
| 14. Troubleshoot simple faults in RE system | | system | |
| 14. Troubleshoot simple faults in RE system | | system | |
| | | 14. Troubleshoot simple faults in RE system | |
| | | | |
| RET 222 1. Connect Solar PV Batteries in series and | RET 222 | 1. Connect Solar PV Batteries in series and | |
| RENEWABLE ENERGY Parallel | RENEWABLE ENERGY | Parallel | |
| TECHNOLOGY AND | TECHNOLOGY AND | | |
| APPLICATION II2. Install the roof top solar PV system | APPLICATION II | 2. Install the roof top solar PV system | |
| 3 Identify the following collectors: | | 3 Identify the following collectors: | |
| Flat plate | | Flat plate | |
| Parabolic | | Parabolic | |
| Parabolic dish | | Parabolic dish | |
| Solar tower | | • Solar tower | |
| | ~ | | |
| 4. Identify different solar dryers. | | 4. Identify different solar dryers. | |
| 5. Identify the components of the Small wind power | | 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 | a Dil |
| | | 8. | Identify the following hybrid power plants: • Wind- Solar • Wind-Hydro • Wind-Biogas • Solar-Biogas | |
| | | | Bohn | |
| | AP. | | | |
| KNOWLEDGE F | PLATFORM ON INCLUSIVE DEVELOPMENT POLICIES | | 138 | |





LIST OF EQUIPMENT FOR NATIONAL DIPLOMA RENEWABLE ENERGY

| LIST OF | EQUIPMENT FOR NATI | ONAL DIPLOMA RENEW | ABLE ENERGY | |
|---------|------------------------------|--|-----------------|-----|
| | | | Facilities | CP. |
| 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 | Assorted |
| Poly-crystalline | " |
| Amorphous-Silicon | " |
| Bi-Facial | " |
| Measuring tape | 5 |
| Safety equipment | Assorted |
| Piping tools | Assorted |
| Roofing tools | Assorted |
| Toolboxes | |
| Electrical | 2 |
| Mechanical | 2 |
| Flywheels | 1 |







| Pumped Hydronower | 1 | |
|---|----------|---------------------------------|
| Compressed Air Energy Storage (CAES) | 1 | |
| Pumped Heat Electrical Storage (PHES) | 1 | |
| Thermometer | Assorted | CP |
| Barometer | 1 | $\langle \bigcup \rangle^{\nu}$ |
| Hygrometer | 1 | \mathbf{O} |
| Temperature probes | Assorted | |
| Air velocity meter | 2 | |
| Solar Irradiation Sensor | Assorted | |
| Batteries | Assorted | |
| Solar charge controllers | | |
| MPPT | 3 | |
| PWM | 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 | |







| | | 4 |
|-----------------------------------|--------|--------|
| Bench Vice | 1 | |
| Rivet gun | 2 | |
| Plywood (Assorted) | 5 each | |
| Personal protective equipment | - | |
| Aluminum ladder/Wooden ladder | 1 | |
| Cables (Assorted) | | \sim |
| Power projector | 1 | |
| Computers | 2 | |
| Pipe Vice | 1 | |
| Plumbing materials PVC (Assorted) | | |
| Projector | 1 | |
| First Aid Box | 1 | |
| Computers | 2 | |
| Insert | | |
| R | | |

| ine Shop | |
|---|--|
| 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 | 3 |
| com Plate accessories | |
| 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 |
| | Ine ShopDescription of EquipmentTool room lathe with swing 483 mm and bed 200 mmCentre lathe with the swing of 330 mm and length of bed 150 mm with com Plate accessoriesColumn/pillar drilling machineUniversal milling machine complete with accessoriesUniversal engraving machine complete with accessoriesSurface grinding machine complete with accessoriesUniversal engraving machine complete with accessoriesPedestal grinding machinePedestal grinding machinePower hacksaw |







| Arbor/hydraulic pressShaping machine with accessoriesUniversal tool and cutter grinderBox spannersAllen Keys (set)Flat screw driver (set) 3 setsPhilips screw driverDrift/pin punches (various sizes)Knurling toolsParallel stripsVernier protractorMicrometers outside 0.25 mm 25-50 mm 50-75 mm and sets of Inside | 1 1 5 2 sets 2 sets 2 sets 2 sets 2 sets 2 sets 2 sets | DUCATION |
|--|---|----------|
| Shaping machine with accessoriesUniversal tool and cutter grinderBox spannersAllen Keys (set)Flat screw driver (set) 3 setsPhilips screw driverDrift/pin punches (various sizes)Knurling toolsParallel stripsVernier protractorMicrometers outside 0.25 mm 25-50 mm 50-75 mm and sets of Inside | 1 1 5 2 sets 2 sets 2 sets 2 sets 2 sets each | DUCATIO |
| Universal tool and cutter grinderBox spannersAllen Keys (set)Flat screw driver (set) 3 setsPhilips screw driverDrift/pin punches (various sizes)Knurling toolsParallel stripsVernier protractorMicrometers outside 0.25 mm 25-50 mm 50-75 mm and sets of Inside | 1 5 2 sets 2 sets 2 sets 2 sets 2 sets each | DUCA |
| Box spannersAllen Keys (set)Flat screw driver (set) 3 setsPhilips screw driverDrift/pin punches (various sizes)Knurling toolsParallel stripsVernier protractorMicrometers outside 0.25 mm 25-50 mm 50-75 mm and sets of Inside | 5 2 sets 2 sets 2 sets 2 sets 2 sets each | JUC F |
| Allen Keys (set)Flat screw driver (set) 3 setsPhilips screw driverDrift/pin punches (various sizes)Knurling toolsParallel stripsVernier protractorMicrometers outside 0.25 mm 25-50 mm 50-75 mm and sets of Inside | 2 sets 2 sets 2 sets 2 sets 2 sets each | |
| Flat screw driver (set) 3 setsPhilips screw driverDrift/pin punches (various sizes)Knurling toolsParallel stripsVernier protractorMicrometers outside 0.25 mm 25-50 mm 50-75 mm and sets of Inside | 2 sets 2 sets 2 sets each | |
| Philips screw driver Drift/pin punches (various sizes) Knurling tools Parallel strips Vernier protractor Micrometers outside 0.25 mm 25-50 mm 50-75 mm and sets of Inside | 2 sets 2 sets each | |
| Drift/pin punches (various sizes) Knurling tools Parallel strips Vernier protractor Micrometers outside 0.25 mm 25-50 mm 50-75 mm and sets of Inside | 2 sets each | |
| Knurling tools Parallel strips Vernier protractor Micrometers outside 0.25 mm 25-50 mm 50-75 mm and sets of Inside | | |
| Parallel strips Vernier protractor Micrometers outside 0.25 mm 25-50 mm 50-75 mm and sets of Inside | 2 sets | |
| Vernier protractorMicrometers outside 0.25 mm 25-50 mm 50-75 mm and sets of Inside | 3 | |
| Micrometers outside 0.25 mm 25-50 mm 50-75 mm and sets of Inside | 3 | |
| 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 cach |] |
| Combination set | 2 | |







| 4 |
|--------|
| 4 |
| 4 |
| 4 |
| 2 |
| 2 |
| 3 |
| 5 |
| 2 |
| 5 |
| 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) | 5 Each |
| | Round rough file (300 mm) | |
| | Round smooth file (300 mm) | |
| | Source rough file (300 mm) | |







| | | 4 |
|--|-------------|---|
| 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 | 10 each |) |
| Dividers | | |
| Steel rule | | |
| Wallets of warding file 10 sets | | |
| Scribers | | |
| Vee block and clamp | | |
| Scribing block | | |
| Centre punches | ~ * - | |
| Cold chisels (set) | | |
| Scrapers (set) | | |
| Vernier Caliper | 3 sets each | |
| Hacksaw frame | | |
| Stock and dies (set) metric | | |
| Taps and wrenches (set) metric | | |
| Hand drill | | |
| Centre drills Lot | | |
| Tap extractor (set) | | |
| Screw extractor (set) | | |
| Screw gauges (assorted) | 2 each | |
| Screw driver (set) and Hammers (assorted weight) | | |
| Measuring tapes | 2 each | |
| Feeler gauges | 2 | |
| Rivet gun pairs | 4 pairs | |
| Goggles | 10 pairs | |
| Drill set | 4 sets | |






| | 4 |
|--|--------|
| Electric Hand drill | 4 |
| Electric hand grinder/sander | 2 |
| Vernier height gauge | 4 |
| Dial indicators and stand | |
| Mallets (rubber, wood/rawhide)/Number stamps | |
| Letter stamps | 3 each |
| Hydraulic press | 3 |
| Punches (cold) | 3 |
| Plier (assorted) | 3 |
| Hand shear | 3 |
| Welding chipping hammer | |
| Wire brush (bench type) | 3 |
| Welding shield | 3 |
| Profile cutting machine | |
| 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 | |

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 | 1 |
| 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 | 2 each |
| wave) | |
| 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 |







| | 4 |
|---------------------------------------|----------|
| 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 | 1 |
| wind turbine system | |
| Wind Energy Unit Charts | Assorted |
| Prototype Vertical Axis Wind Turbine (VAWT) – instructional | 2 |
| material | |







| Prototype of Horizontal Axis Wind Turbine (HAWT) – | 2 |
|--|----------|
| instructional material | |
| 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 | |
| Rectangular notch weir | 2 |
| Water current meters | |
| 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

| | Flowmeters | | |
|--------|---|--------|---------------|
| | Manometers | | 1 |
| | | | |
| | | | |
| Electr | onics Laboratory | | |
| S/N | Equipment | Requ | ired Quantity |
| | Semiconductor Diode Characteristics Apparatus | 4 | |
| | Analog Lab Trainer Kit | 5 | |
| | Transistor Characteristics demonstrator | 5 | |
| | Oscilloscopes: | | |
| | - Single trace 5MHz Probe | 2 | |
| | - Dual trace 15 MHz 5 | 2 | |
| | - 100Mhz | 1 | |
| | Signal generators (AF, RF) | 2 eacl | h |
| | Transistor tester | 3 | |
| | Amplifier Characteristics Apparatus | 3 | |
| | FET Tester | 3 | |
| | Power supply unit 0-60v/3A | 5 unit | ts |
| | 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 | 5 | |
| | 0- 1000m A AC | 5 | |
| | Microammeter: | | |







| 0- 1000 μA DC | 5 |
|----------------------------------|----|
| 0- 1000 µA AC | 5 |
| Millivolmeter | |
| 0- 1000m V DC | 5 |
| Galvanometer (triple pole range) | |
| 30-0-30m A | 10 |
| 500-0500m A | 10 |
| 5-0-5m A 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 | 1 |
| Digital IC Trainer | |
| Flip Flop Trainer | |

Fluid Mechanics/Hydraulics Lab

| S/N | Description of Equipment | No. Required |
|-----|--|--------------|
| 1. | Hydraulics Bench with accessories for various experiments in | 1 |
| | fluid flow measurements | |
| 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 |
|---|--|----|
|---|--|----|



X



| 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 | |
| 21 | Gas laws apparatus | 1 |
| 27 | Fire extinguishers | 4 |
| 28 | Sand and water buckets | 4 |
| 29 | Air thermometer constant volume | 4 |
| Drawi | ing Studio | |

Drawing Studio

| 1 | Drawing table complete with drafting machine/stood | 30 |
|----|--|----------|
| 2 | Drawing set complete with pens for ink work | 2 |
| 3 | 45° set squares | 2 |
| 4 | 60° 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 $(45^\circ, 60^\circ)$ | 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 | \sim |
| | | | |
| Comp | uter Studio | \sim | Y |

Computer Studio

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







LIST OF PARTICIPANTS FOR THE REVIEW OF NATIONAL DIPLOMA RENEWABLE ENERGY TECHNOLOGY

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