AE CURRICULUM DRAFT - 2

PROGRAMME SPECIFICATION

1. GENERAL INFORMATION

PROGRAMME TITLE: **Diploma in Alternative Energy Technology**
FINAL AWARD: **Ordinary Diploma (A1)**
EXIT AWARD: **None**
AWARDING BODY:
APPROVAL DATE:
College: **Tumba College of Technology (Institut Technique Supérieur de Tumba)**
HOST DEPARTMENT: **Alternative Energy**
COLLABORATOR: **Kigali Institute of Science and Technology (KIST)**

1.1 Rationale

To improve the human resources in the technical side in Rwanda, one measure is to decrease the problems of employment to graduates from technical secondary schools (ETO's), the government has decided to start A1 program to improve their employability.
Alternative energy is one of the areas considered, as it will address the energy problems facing the country and boost social development in the country.

The program is intended to provide a balanced mix of Professional Technology knowledge in both theory and practical skills. In addition it will provide an introductory knowledge of Entrepreneurship to promote self employment.

From the employer's point of view, there is a strong demand for Technicians in Rwandese industries that are more knowledgeable and practical. This makes the Graduates of the program to expect excellent career opportunities.

1.2 Students Profile

The program shall be open to local and international students interested in pursuing career on Alternative Energy or who wants to be entrepreneurs in the this fields. Candidates holding a Technical High School (ETO's) certificate from the Rwanda National Examination Council (RNEC) and meets the minimum entry point of as specified by the Ministry of Education shall be eligible for admission into the program. The program will be open mainly for full-time students. Some arrangement can be made for special program for those who are interested in alternative energy profession as long as the program is economical and convenient to run. For foreign applicants, their certificates have to be verified by RNEC for their authenticity and the minimum entry points depending on the current conversion structure.

1.3 Teaching Staff Profile

The program will use staff with a minimum of a university degree or equivalent in or related to the area being taught. For skills development, at least highly skilled Workshop Instructors are required. It is important to emphasize that certificate does not mean skills learned.

2 EDUCATIONAL AIMS OF THE PROGRAMME

The objective of the courses offered is to produce graduates who will become Technician who will be able to work independently and supervise artisans during the construction, installation and maintenance of alternative energy systems suitable for Rwanda. The graduates should be able to design and carry out economic assessment of alternative energy systems. They should also be able to carry out different types of maintenance required for alternative energy systems. The graduates will attain academic skills and professional competence that will give them a solid command in the alternative energy disciplines.

The graduates will have the ability to transfer knowledge and skills obtained to the society and the community around them. Their knowledge in entrepreneurship may be good nucleus (seed) for establishing more spin-off enterprises in the alternative energy and related technologies.

This program has great potential of attracting scholars from the region and beyond, given that energy problems exist in the region and the uniqueness of the program makes it relevant.

3. INTENDED LEARNING OUTCOMES

3A Knowledge and understanding

A1 Understand the importance of alternative energy to the society and its availability economically.

A2 Develop the ability to plan lessons and employ the best teaching methodology.

A3 Develop Skills required to teach their respective subjects and the use of appropriate technologies available.

A4 Know the opportunities for starting small and medium enterprises in their respective specialization.

3B Intellectual Skills

B1 Students are able to design lessons and use the best teaching method to teach them.

B2 Students are able to design, make analysis (e.g. sizing of components, and safety factor computations), and implement the design (making the product)

B3 Students are capable of determining the most appropriate production methods for implementing their design

B4 Students can produce business plans and implement them

3C Professional/Practical Skills

C1 Students are able to plan and teach related technical subjects

C2 Students are able to supervise design, production, and installation of technical items that are useful to society.

C3 Students are able to service equipment in their related profession

C4 Students are capable of making feasibility studies, prepare project plans, and supervise implementation of such plans.

3D Transferable/Key Skills

D1 Plan and produce or service technical items.

D2 Knowledge and techniques that are needed in industries for installation and maintenance of machines

D3 Technologies in their respective fields

D4 Principles of establishing enterprises and running them

3E Industrial Attachments

After completing the 4th semester, each student shall be attached with industries/companies operating/implementing in Rwanda in one or all of the following sectors for a period of four months:

- Hydropower development sector
- Solar power (PV and or thermal) sector
- Biogas sector (domestic or institutional)
- Biomass sector (domestic or institutional)

After completion of the industrial attachment each student shall submit a detail report consisting of the followings which shall be marked as per the regulation of TCT:

- Introduction of the industry/company along with its vision, mission and objectives
- Its organization structure and responsibilities of key figures
- Milestones of achievements of the industry/ company
- Detail description of works carried out/observed (50% weightage)

- Detail description of skill/knowledge gained during the industrial attachment
- Difficulties faced during the industrial attachment
- Suggestions on how these difficulties could be solved for future students
- Detail description of skills/knowledge gained during the industrial attachment
- Recommendation/to whom it may concern letter from the immediate supervisor of the industry/company to tha attached student about her/his performance

3F Special Professional Lectures by Technical Director/Senior Engineers from the industry/company

At least 8 periods of lectures (2 periods x 4 times in 4 fields) as far as possible be arranged before the end of fourth semester by the Technical Director/ Senior Engineers covering the following topics with particular reference to ongoing or completed projects in Rwanda:

- The need/objective of the project
- Reason for selecting the site of the project
- Partners of the project
- Benefits of the project for the country/district/community
- Manpower involved in the project
- Brief technical details of the project (feasibility study, preliminary design, detail design, technical specifications of components used in the project, procurement procedures, transportation of key components, installation procedures, commissioning of projects (60% weightage)
- Relevant drawings of the project
- Special precautions taken during the installation of the key components of project
- Repair and maintenance schedule of the key components of the project
- Expansion programme of the project in future if any

4. PROGRAM STRUCTURES

4.1 Course structure:

Year 1- Semester 1

Serial Number	Course Code	Course Title	PERIODS/WEEK			
			L	T	P	Total
1	EN 111	Intensive English	8	1	0	8
2	MA 112	Mathematics	3	1	0	4
3	CA 113	Computer applications	1	0	3	4
4	AE 114	Introduction to energy and energy sources	2	1	0	2
5	AE 115	Introduction to electricity and magnetism	3	1	0	4
6	AE 116	Introduction to electronics	2	0	2	4
7	AE 119	Technical drawing I	1	0	3	4
TOTAL PERIODS			**20**	**4**	**8**	**32**

Year 1–Semester 2

Serial Number	Course Code	Course Title	PERIODS/WEEK			
			L	T	P	Total
1	EN 121	Technical English	3	0	0	3
2	AE 122	Basics of biogas	2	1	1	4
3	AE 123	Basics of micro-hydro power	3	1	0	4
4	AE 124	Basics solar energy	2	1	1*	4
5	AE 126	Workshop technology I	0	0	8	8
6	AE 127	Project planning and management	3	1	0	4
7	AE 128	Introduction to electrical machines	2	1	2	5
8	AE 129	Technical drawing II	1	0	3	4
TOTAL PERIODS			**16**	**5**	**15**	**36**

* 3 periods practical work, 4 times per semester

Year 2–Semester 1

Serial Number	Course Code	Course Title	PERIODS/WEEK			
			L	T	P	Total
1	AS 211	Applied sociology	3	1	0	4
2	AE 212	Design of biogas plant	3	1	0	4
3	AE 213	Design of micro hydro power system	3	1	0	4
4	AE 214	Design of solar energy system	2	1	1*	4
5	AE 215	Work shop technology II	0	0	8	8
6	AE 216	Biomass and design and construction of cooking stoves	1	0	3	4
7	AE 217	Computer aided drawing	2	0	3	5
8	AE 218	Project I	0	0	2	2
TOTAL PERIODS			**14**	**4**	**17**	**35**

Year 2–Semester 2

Serial Number	Course Code	Course Title	PERIODS/WEEK			
			L	T	P	Total
1	AE 221	Construction work in biogas plant	1	0	4	5
2	AE 222	Construction work in solar system	1	0	4	5
3	AE 223	Construction work in micro hydro power plant	2	0	4	6
4	AE 224	Entrepreneurship	2	1	0	3
5	AE 225	Work shop technology III	0	0	8	8
6	AE 226	Project implementation (Project II)	0	0	6	6
TOTAL PERIODS			**6**	**1**	**26**	**33**

4.2 Program Content

CODE: EN 111 **TITLE: Intensive English (120 15 0)**

Course code: EN 111
Subject: Intensive English
Category: EN
Semester: I
No. of class week: 12
Lecture/ week: 8 periods
Tutorial/week: 1
Practical/week: 0

Objective:
To enable students to use proper technical English terms in his professional day to day communications.

Learning outcomes

- Be able to use proper grammatical structures
- Be able to use appropriate technical terms in report writing
- Be able to write commercial letters

Content:

I- Grammar:
Word Formation with prefixes and Suffixes-Deriving other forms of words from the given form-active and passive voice-simple present, present continuous, present perfect and past continuous tenses-gerunds-conditional sentences-standard abbreviations compound nouns-nominal compounds-adjectives-meaning of words definitions correcting the sentences-filling the blanks with words given in the brackets-punctuation, statements of comparison, Instruction(Use of should and the imperative).
Synonyms and antonyms-Preposition-relative-adverbs-connectives-expressions of cause and effect-purpose and means

II- Comprehension and Transco ding:

Test a reading comprehension: An unseen passage followed by (i) true or false (ii) Multiple choice (iii) sentence completion (iv) short answer and Questions etc.
Transco ding: (a) A simple diagram (b) A simple flow chart (c) A simple classification (d) A simple tree diagram.

III- Report writing and letter writing:

Writing of Laboratory report, Writing of Technical reports
Letter inviting dignitaries to preside over a function-letter accepting an invitation-letter declining an invitation-letter to the editor-requisition letter for practical training-application for a job with bio-data

IV- Commercial letters:

a. Specification of common Engineering Equipments and tools-Calling for the quotations for the supply of equipments like Hardware and Computer Network, System software, Application software, Web design equipments, generators for power supply, Electronic devices and other Computer and electronic laboratory Components.
b. Placing orders.
c. Asking for clarification.
d. Letter of complaint regarding some manufacturing defects.

V- Essays:

Writing essays on topics of Scientific and Technological important especially in the field of electronics/Computer and not exceeding 500 words.

Note: During the class period/hour, group discussions, debates, speeches, seminar and conversation etc. should be arranged to improve the communication skill.

Recommended books:

1. *Communication in English for technical/vocational students-Curriculum development center*, Calcutta, Orient Longman**.**
2. *The Structure of Technical English*-AJ.Herbert, Orient Longman**.**

Assessment: Coursework: 20% Course Test: 20%, Examination 60%

CODE: MA 112 **TITLE: Mathematics I (45 15 0)**

Course code: MA 112
Subject: Mathematics
Category: MAT
Semester: I
No. of class week: 12
Lecture/ week: 3 periods
Tutorial/week: 1
Practical/week: 0

Course Objective

To provide the student with mathematical concepts and techniques necessary for solving engineering problems

Specific Learning Outcomes

On completion of the course the student should be able to:

- Execute operations involving complex numbers
- Execute operations with vectors in two and three dimensions
- Understand matrix algebra and its applications
- Describe and Characterize lines, planes, conic sections and quadric surfaces
- Find minima and maxima of a function
- Sketch a function's curve
- Calculate arc lengths and areas

Course Contents

Complex Numbers: Definition, Properties, Algebraic Operations and Applications, Cartesian and Polar Representations. Absolute Value Products, Powers and Quotients Extraction of Roots De Moivre's Theorem

Vectors**:** Vector spaces, vectors in two and three dimensions, vector algebra, inner product (dot product), cross product and applications.

Matrices**:** Matrix algebra, solution of systems of linear equations, determinants, inverses and characteristic values.

Analytical Geometry**:** Plane analytical geometry; conic sections, translation and rotation of axes. Analytical geometry in three dimensions (lines, planes, spheres, quadric surfaces).

Calculus*:*

The concept of functions: Elementary and Transcendental Functions of a real Variable. Exponential, Hyperbolic and Logarithmic Functions of a real variable

The derivative and applications: curve sketching, maxima and minima, velocity and acceleration; trigonometric, exponential and logarithmic functions.

Definite and indefinite integrals: area, work, arc length. Techniques of differentiation and integration

Textbooks:

1) Calculus and Analytical Geometry by W. Foley
2) Differential and Integral Calculus, Volume 1&2, by Piskunov

Assessment: Coursework: 40%, Final Exam: 60%

CODE: IT 113 **TITLE: Computer applications (15 0 45)**

Course code: IT 113
Subject: Computer applications
Category: IT
Semester: I
No. of class week: 12
Lecture/ week: 1 period
Tutorial/week: 0
Practical/week: 3

Objective:
To provide the students with practical skills to enable them to use different computer application software in their daily work

Learning outcomes:

- Be able to use comfortably Microsoft Windows
- Be able to use comfortably Microsoft Word
- Be able to use comfortably Microsoft Excel
- Be able to use comfortably the Internet

Introduction to Computers & Windows:
Definition of Computers, Advantages & Disadvantages of computers, Hardware and Software definitions Block structure of computers and function of components: Central Processing Unit, Definition of Input devices, Output devices and Storage Devices. Software Types: Operating systems & utilities, Development Software / Programming languages, Application Software types & use General precautions of computer, Routine care & maintenance, Viruses & control.

Learning Windows:
Getting started with Windows, Opening a Document, Getting Help, Finding something on your computer, changing system settings, starting a Program by using the run command. Shutting down your computer, creating folders, organizing files and folders, working within documents

MS Word: Creating a word Document, Formatting pages: Using mail merge.

MS Excel : Introduction, spreadsheet features, defining spreadsheet, entering Data and formatting a worksheet, working with functions, logical functions, creating charts, managing multiple sheet documents.

Internet: Launch a Web browser, get a web page, bookmark frequently used pages, use a search engine, use of e-mail.

Recommended text books: Teach yourself MS Word & Excel 97 by SAMS, Windows NT4 Programming by Schildt.

Assessment: Assignment: 10%, Test: 10%, Practical: 60%, Final Examination: 20%

CODE: AE 114 **TITLE: Introduction to energy and energy sources (30 15 0)**

Course code: AE 114
Subject: Introduction to energy and energy sources
Category: AE
Semester: I
No. of class week: 12
Lecture/ week: 2 periods
Tutorial/week: 1
Practical/week: 0

Objective of the course: To familiarize students with different energy sources, their impact on socio-economic development, climate change and energy security.

Expected output: The students will be able to relate different energy sources with economic development, environment protection and energy security with particular reference to Rwandan situations.

Course content

Topic — Duration in Periods

1. Types energy: potential energy, kinetic energy, mechanical energy, electrical energy, chemical energy, electro-magnetic energy, thermal energy and sound energy, difference between conventional and non-conventional energy sources. [2]

2. Units of energy: relation between energy, power and time, different units of energy and their conversion from one unit to other units, calorific values of different types of fuels. [4]

3. Introduction to hydro-power (types, power calculation, main components, advantages and disadvantages). [2]

4. Introduction to wind energy (relation between output wind power and wind velocities, wind velocity measurement and application). [2]

5. Introduction to geothermal energy (Origins, benefits, applications) [2]

6. Introduction to solar energy (solar radiation, direct, diffuse and global radiation). [2]
   6.1. Solar thermal energy
   6.2. Solar photovoltaic energy

7. Introduction to hydrogen, nuclear, wave, and tidal energy (brief working principle and application). [2]

8. Introduction to bio-energy (fuel-wood, bio-liquid and biogas). [4]
   (Calorific values, Green house gas effect, Green house gas emissions, benefits from the Clean Development Mechanism)
9. Energy situation in Rwanda (types of sources used, per capita energy consumption, available sources, future potential) [4]

References:

1. Douglas M. Considine, Editor in Chief, Energy technology handbook, McGraw-Hill Company (latest edition).
2. Bent Sorensen, 2004, Renewable energy, 3rd edition, Academic Press, An imprint of Elsevier, 84 Theobald's Road, London, WC1X 8RR, U.K.
3. D. Yogi Goswami et al, 1999, Principles of solar engineering, 2nd edition, distributed by Taylor and Francis, 1 Gunpowder Square, London, EC4A 3DE, U.K.
4. Godfrey Boyle, Editor, 2005, Renewable Energy, 2nd edition, Oxford University Press, Oxford in association with The Open University, Milton Keynes, U.K. (www.oup.com)
5. Martin Green, 1992, Solar cells, operating principles, technology and system applications, Prentice-Hall Inc., Englewood Cliffs, N.J. 07632, USA,
6. S.P.Sukhatme, 1992, Solar Energy, Eighth Reprint or latest, Tata McGraw-Hill Publishing Company Limited, New Delhi.
7. UNDP, 2000, World Energy Assessment, New York, United Nations.
8. UNEP 2007, UNEP handbook for drafting laws on energy efficiency and renewable energy resources.
9. Course Manual– to be prepared

Assessment: Course work 40%, Final Exam: 60%

CODE: AE 115 TITLE: Introduction to electricity and magnetism (45 15 0)

Course code:	AE 115
Subject:	Introduction to electricity and magnetism
Category:	AE
Semester:	I
No. of class week:	12
Lecture/ week:	3 periods
Tutorial/week:	1
Practical/week:	0

Objectives: To provide the fundamental knowledge in both electricity and electromagnetism to students, such as: theories of direct and alternating current, and basic laws used in electricity and electromagnetism.

Learning Outcomes:
On completion of this subject the student will be able to:

- Understand the process of electric power generation.
- Understand the principles through which electric machines/equipments operate.

Contents: Introduction, direct current electricity: (review d.c. circuit elements and their respective roles, measurement of potential difference by the use of voltmeters, circuit calculations by (ohms law; Kirchhoff's laws, Thevenin law.), electric energy and power.

Electromagnetism: Introduction, poles of a magnet, laws of magnetic force, magnetic field, magnetic flux, magnetic flux density, absolute and relative permeability, magnetic effect of electric current, right hand rule and left hand rule, current carrying conductor in magnetic field, magnetic circuits (introduction, magnetic circuit, analysis of magnetic circuit, magneto motive force, reluctance, permeance, comparison between magnetic and electric circuits, flux leakage, the B-H curve, magnetic hysteresis, hysteresis loop).
Electromagnetic induction (magnetic flux, condition for generation of current ,Lenz's law and faraday's law of electromagnetic induction ,magnitude of induced emf, apparent power, active power and reactive power.

Alternating current: Properties and production of alternating current, comparison between AC and DC, DC to AC conversion and vice versa.

Recommended text books: Electrical Technology by Hughes.
Principles of electrical engineering and electronics by V.K.Metha

Assessment: Course work 40%, Final Exam: 60%

CODE: AE 116 **TITLE: Introduction to electronics (30 0 30)**

Course code:	AE 116
Subject:	Introduction to electronics
Category:	AE
Semester:	I
No. of class week:	12
Lecture/ week:	2 periods
Tutorial/week:	0
Practical/week:	2

Objectives:
To provide the basic knowledge on electronic components and to apply the concept of electronics in alternative energy field.

Course outcomes:
At the end of this course student will be able to:
- use electronics components in alternative energy where necessary.
- understand and explain the basic principles of electronics.

CONTENTS

Semiconductor physics
Semiconductor bond, crystals, energy band, hole and electrons current, intrinsic semi conductor pn junction.

Semiconductor diode
Diode equivalent circuit, important terms, half wave rectifier, full wave bridge rectifier, zener diode, LED, photodiode.

Bipolar transistors (NPN) and (PNP)
Naming the transistor terminals pnp and npn junctions, common base, common emitter, common collector transistor**;** biasing of transistor simple formula and calculations, basic concepts of transistor amplifier, heat sink.

Field effect transistor (JFET and MOSFET)
Working principle; naming the transistor terminals; biasing of transistor; different configurations of transistor; simple formulas and calculations; comparison between field effect transistor and bipolar transistor.

Thyristor (Silicon controlled rectifier)
Working principle, equivalent circuit, V-I characteristics, application, symbol and internal structure.

TRIAC and DIAC
Operation and construction; symbol and internal structure; application of DIAC and TRIAC, difference between DIAC and TRIAC.

Unijunction transistor
UJT equivalent circuit UJT characteristics; application of UJT

Isolated gate bipolar transistor (IGBT)
Working principle and application.

Gate turn off thyristor (GTO)
Working principle and application.

Electronics converters:
Rectifier, inverter, chopper, cycroconverter: their main circuits, working principle and application.

Digital electronics
Digital circuits numbers system, such as binary, decimal, octal; conversion of numbers system; logic gates: OR gate, AND gate, NOT gate, exclusive gate, Boolean algebra, Boolean theorem, DeMorgan's theorem

Recommended text books:

- **Principles of electronics by V.K .Mehta**
- **Basic electronics and linear circuits by N Bhargava, D C Kulshreshtha, S C Gupta.**
- **Electronics principle, by Albert Malvino, McGraw Hill, 1999, 7th Edition**

Assessment: Course work 10%, Test 30%, Exam 60%

CODE: AE 119 **TITLE: Technical drawing I (15 0 45)**

Course code: AE 119
Subject: Technical drawing I
Category: AE
Semester: I
No. of class week: 12
Lecture/ week: 1
Tutorial/week: 0
Practical/week: 3

Objective of the course: To make student read and interpret the technical drawings.

Expected output: The students will be able to read and understand the technical drawings and work independently as per provided drawings.

Course content

Topic		Duration
1.	Introduction to technical drawing	[1+0]
	1.1. Meaning of technical drawing	
	1.2. Types of technical drawing	
	1.3. Technical drawing as a universal language	
	1.4. Intended outcome of the technical drawings	
2.	Drawing equipment, practices and techniques	[1+3]
	2.1. Equipment and materials Drawing instruments, auxiliary equipment and drawing materials	
	2.2. Practicing the use of drawing instruments Pencil sharpening, securing paper, paper size, proper use of T-square, triangles, scales, dividers, compasses, French curves	
3.	Freehand technical lettering practice Letter proportions, line thickness, inclined & vertical letters, upper and lower cases, numbers/fractions	[1+3]
4.	Dimensioning	[1+5]
	4.1. Fundamentals and techniques Size & location dimensioning, use of scales, measurement units, reducing & enlarge drawings	
	4.2. General dimensioning practices Placement of dimensions, aligned & unidirectional Recommended practices	
5.	Geometrical construction	[2+10]
	5.1. Plane geometrical construction • Bisecting a line, dividing a line into equal segments • Construction of angles, triangles, squares, polygon, ellipse • Bisecting angles, circumscribing and inscribing polygons • Drawing a circle tangent to a line	
	5.2. Solid geometrical construction	

- Prisms – square, cubical, triangular and oblique
- Cylinders – right and oblique
- Cones – right and oblique
- Pyramids – square, triangular, oblique, truncated

6. Orthographic projection [2+10]
   - 6.1. Principal views
   - 6.2. Methods of obtaining orthographic views
   - 6.3. Projection of lines, angles and plane surfaces, analysis in three views
   - 6.4. Projection of curved lines and surfaces
   - 6.5. Object orientation and selection of views for best representation
   - 6.6. Full and hidden lines
   - 6.7. Introduction to isometric drawing

7. Sectioning [1+8]
   - 7.1. Purpose of sectioning
   - 7.2. Types of section views
   - 7.3. Specifying cutting planes for sections
   - 7.4. Dimensioning

Notes:

- Allocated time is for lecture as well as for practical classes. Few lectures are conducted for explanation and more emphasis is given on practical exercises in the class.
- It is suggested to design practical exercises on each sub topics so that student learn and practice systematically.
- Drawing boards are provided by TCT. Other drawing instruments should be brought by the students.

Assessment: Course work 40%, Exam 60%

Reference:

1. Frederick E. Giesecke, Alva Mitchell, Henry C. Spencer, Ivan Leroy Hill, John Thomas Dygdon, James E. Novak, 2002, Technical Drawing, 12 Edition, Prentice Hall.
2. Basic technical drawing, Student edition, 2002, McGraw-Hill.
3. Dhawan R.K., 2005, A text book of machine drawing, S.Chand & Co., New Delhi.
4. Gill P.S., Engineering drawing, S.K. Kataria & Sons, New Delhi
5. Practical exercise sheets

Code: EN 121 **TITLE: Technical English (45 0 0)**

Course code:	EN 121
Subject:	Technical English
Category:	EN
Semester:	II
No. of class week:	12
Lecture/ week:	3 periods
Tutorial/week:	0
Practical/week:	0

Objectives:
To enable students to use proper technical English terms in their professional day to day communication

Learning outcomes;
At the end of this course students will be able to;

- Use proper grammatical structures
- Be able to use technical terms in their day to day communication
- Be able to write technical commercial letters

Contents:
Introduction: A review on the previous work such as (English speaking, writing, listening), text related to AE field will given to students.
Comprehension and transcoding: Test a reading comprehension: An unseen passage followed by true or false, multiple choice, Sentence completion, Short answer and question
Transcoding: Simple diagram, a simple flow chart, a simple classification, a simple tree diagram
Report writing and letter writing: Writing laboratory report, write project document such as alternative energy project proposals, feasibility study reports and technical specifications. Letter writing such as application letters, official letters and requisition letters.
Commercial letters: Specification of common alternative energy equipments and tools, draft of alternative energy contract agreement and tender documents.
Essay writing: Writing essays on alternative energy topics not exceeding 500 words.
Note: During the class period, group discussions, debates, speeches, seminar and conversations should be arranged to improve communication skills.

Recommended Books:
English for electronics, Basic technical English, English for computing, English for electrical and mechanical engineering, Basic English for computing.

Assessment: Course work 10%, Test 30%, Examination 60%

CODE: AE 122 **TITLE: Basics of biogas (45 15 0)**

Course code: AE 122
Subject: Basics of biogas
Category: AE
Semester: II
No. of class week: 12
Lecture/ week: 2 periods
Tutorial/week: 1
Practical/week: 12* (* classes depends on progress of biogas plant)

Objective of the course: To enable the students to understand the basics of biogas technology.

Expected output: The students will be able to explain biogas technology as an alternative energy sources and its fertilizer value.
The students will be able to apply it in solving energy as well as fertilizer problems.

Course content

Topic		Duration
1.	Utilization of biogas and bio-slurry	[5]
1.1	Biogas definition, composition and raw materials	
1.2	Anaerobic digestion process and microbial activities	
1.3	Various uses of biogas	
1.4	Utilization of bio-slurry as feed and fertilizer	
1.5	Biogas in relation to other discipline	
2.	Factors affecting biogas generation	[4]
2.1	Nature of feeding materials	
2.2	Loading rate, retention time and consistency of slurry	
2.3	Role of temperature, PH and C/N ratio	
2.4	Toxicity	
3.	Designs/classifications of Biogas Plant	[4]
3.1	Essential components of biogas plant	
3.2	Various types of biogas plants (floating, fixed, others)	
3.3	Various types of feeding (continue, semi-continue, discontinue/batch)	
4.	Components of biogas plant	[6]
4.1	digester/fermentation chamber	
4.2	Dome/gas holder	
4.3	Inlet, outlet and mixing chamber	
4.4	Foundation and turret	
4.5	Main gas valve, gas exit and water drain	
4.6	Manometer, pressure gauze	
5.	Maintenance of biogas plant	[5]
5.1	Safety precautions	
5.2	General maintenance (daily, monthly, annually)	

5.3 Maintenance of biogas stove, lamps and other appliances
5.4 Trouble shooting (gas leakage, etc.)

List of practical works

1. Construct a biogas plant at TCT (Timing of practice to be arranged) [12]
   1.1 Slurry preparation for feeding the plant
   1.2 Filling the digester with slurry mixture
   1.3 Plant operation
   1.4 Gas production
   1.5 Gas utilization (cooking and lighting)

References:

1. Karki, A.B., Shrestha, J.N. and Bajgain, S. (2005) Biogas as a Renewable Sources of Energy in Nepal: Theory and Practice. BSP-Nepal
2. Construction Standard, Biogas Model (1999) GGC-2047, BSP-Nepal
3. Course manual – to be prepared

Recommended text books: Technology and application of biogas by Jain Brothers (New Delhi); Energy technology by Dr B.B Parlekar & S RAO

Assessment: Course work 10%, Test 30%, Examination 60%

Code: AE123 **TITLE: Basics of micro-hydro power (45 15 0)**

Course code: AE 123
Subject: Basics of micro-hydro power
Category: AE
Semester: II
No. of class week: 12
Lecture/ week: 3
Tutorial/week: 1
Practical/week: 0

Objective of the course: To familiarize student with the MHP system and their components and benefit of rural electrification for the economic development of country.

Expected output: The students will be able to describe the main components of MHP system and the benefits from it to the rural development activities in the country.

Course content

Topic		Duration
1.	Introduction to MHP technology	[1]
	1.1 Power from water	
	1.2 Classifications of hydropower, end uses	
2.	Technical aspects of MHP plant	
	2.1 Main components of MHP plant (diversion intake, desanding basin, canal, forebay, spillway, penstock, power house, tailrace and transmission/ distribution system)	[4]
	2.2 Suitable conditions for MHP	[0.5]
	2.3 Potential power from MHP (power calculations and other important aspects such as power requirement for lighting, agro-processing, running cottage industries, willingness to pay the electricity bill)	[4]
	2.4 Types of turbine: impulse (pelton, turgo, crossflow) and reaction (francis, kaplan, propeller)	[2]
	2.5 Types of generator: induction generator, synchronous generator	[2]
	2.6 Control panel, load control governors (mechanical, hydraulic, electronic load controller), dummy load	[2]
	2.7 Transmission and distribution lines, consumer connection	[2]
	2.8 Plant efficiency	[1]
	2.9 Load factor	[0.5]
	2.10 Operation and maintenance of MHP plant	[2]
3.	Energy management	[4]
	3.1 Demand limiters	
	3.2 Time diversity for high load uses	
	3.3 Pre-payment metering	
	3.4 Payment by metering	

4. Application of MHP [4]
   - 4.1 Agro-processing
   - 4.2 Battery charging
   - 4.3 Lighting houses
   - 4.4 Small scale industries

5. Failure of MHP plant [2]
   - 5.1 Insufficient site studies
   - 5.2 Effects of floods and landslides
   - 5.3 Uneconomical canal length
   - 5.4 Insufficient structures for service & repair
   - 5.5 Inability to pay tariffs by targeted population

6. Sustainability of MHP plant [2]
   - 6.1 Technically feasible
   - 6.2 Socially acceptable
   - 6.3 Community management
   - 6.4 Financially viable

7. Future prospects of MHP project in Rwanda [3]
   - 7.1 List of potential MHP projects identified by Ministry of Infrastructure
   - 7.2 Literature study of one of the potential MHP projects

Note:
A site visit is arranged to the students to the nearest existing MHP plant and rural community.

Reference:

1. ITDG, 2002, Civil works guidelines for Micro-hydropower in Nepal, ITDG Nepal, ISBN: 99933-95-01-3
2. Boyle, R., 2004, Renewable energy, Oxford University Press, Second Edition, UK
3. Adam Harvey, 1993, Micro Hydro design Manual, Intermediate Technology Publication
4. ICIMOD, 1999, Manuals on MHP for Installation and Commissioning, Maintenance and Repair, Operation and Management.
5. Course manual – to be prepared

Recommended Books: Power plant engineering by Er R.K Rajput; micro hydro power (a guide for development workers) by P. Frankel.

Assessment: Course work 10%, Test 30%, Examination 60%

CODE: AE124 **TITLE: Basics of solar energy (30 15 15*)**

Course code: AE 124
Subject: Basics of solar energy
Category: AE
Semester: II
No. of class week: 12
Lecture/ week: 2 periods
Tutorial/week: 1
Practical/week: 3* (* classes only in week no. 3,6,9,11)

Objective of the course: To familiarize students with different energy sources, fundamental principles of solar thermal and solar PV. This will enable them in using solar energy for the improvement of quality of life.

Expected output: The student understands components of solar and PV systems.

Course content

Topic		Duration
1	Irradiance, insolation and measurement using pyranometers for a given location.	[1]
2.	Basics of solar thermal energy (electromagnetic spectrum, reflection and absorption of radiation, albedo effect, air mass, solar time, equation of time, prediction of solar energy).	[3]
3.	Flat plate solar water heaters (construction, basic energy equation, heat transfer, natural circulation systems, forced circulation system, temperature distribution, heat removal and flow factors, heat capacity effects, performance measurement of solar water heaters).	[4]
4.	Working principles and construction of solar box, parabolic cookers, solar dryers and solar still.	[2]
5.	Working principles of solar PV cells (types of cell, output power versus area of solar cell, efficiency).	[1]
6.	I – V curve of solar cells and effect of ambient temperature and irradiance on power output of a solar cell.	[1]
7.	Solar PV cell, solar PV module, solar array, application of protection diodes in PV modules.	[1]
8.	Series and parallel connection of solar PV modules.	[1]
9.	Fundamentals of solar charge controllers.	[1]
10.	Batteries – capacity of battery and discharge rate (SOC, DOD, charging efficiency, effect of temperature, maintenance of batteries).	[2]

11. Lamps (DC, AC and white LED lamps and power consumption and their intensity) [2]
12. Inverters [2]
    - 12.1. DC – DC converters
    - 12.2. DC – AC inverters
    - 12.3. Power conditioners for grid connected system
13. Selection criteria of PV module, battery and charge controllers for a simple solar home system (SHS) using specifications from provided catalogues. [2]
14. Possibility of solar energy applications in Rwanda. [1]

List of practical works (3 periods/week)

1. Measurement of solar radiation using pyranometer, measurement of indoor light intensity using lux meter, procedure for calculation of solar insolation value based on 6 am to 6 pm solar radiation data using pyronometer. [3 periods in week # 3]
2. Measurement of cooking time using box type and parabolic type solar cookers and measurement of temperature in solar water heaters and production of distill water using solar still. [3 periods in week #6]
3. Measurement of PV module (I – V curve, $V_{oc} = f(t^oC)$; $I_{sc} = f(\text{Irradiance})$, effect of partial shadow. [3 periods in week #9]
4. Connection of a simple solar home system (using components like PV module, charge controller, batteries, junction box and lamps). [3 periods in week #11]

* Demonstration of PV Water Pumping System PS (both submersible and surface type) and solar freeze.

References:

1. Douglas M. Considine, Editor in Chief, Energy technology handbook, McGraw-Hill Company (latest edition).
2. Bent Sorensen, 2004, Renewable energy, 3rd edition, Academic Press, An imprint of Elsevier, 84 Theobald's Road, London, WC1X 8RR, U.K.
3. D. Yogi Goswami et al, 1999, Principles of solar engineering, 2nd edition, distributed by Taylor and Francis, 1 Gunpowder Square, London, EC4A 3DE, U.K.
4. Godfrey Boyle, Editor, 2005, Renewable Energy, 2nd edition, Oxford University Press, Oxford in association with The Open University, Milton Keynes, U.K. (www.oup.com)
5. Martin Green, 1992, Solar cells, operating principles, technology and system applications, Prentice-Hall Inc., Englewood Cliffs, N.J. 07632, USA,
6. S.P.Sukhatme, 1992, Solar Eenergy, Eighth Reprint or latest, Tata McGraw-Hill Publishing Company Limited, New Delhi.
7. UNDP, 2000, World Energy Assessment, New York, United Nations.
8. UNEP 2007, UNEP handbook for drafting laws on energy efficiency and renewable energy resources.
9. Course Manual – to be prepared

Assessment: Course work 10%, Test 30%, Examination 60%

CODE: AE 126 **TITLE: Workshop technology I (0 0 120)**

Course code:	AE 126
Subject:	Workshop technology I
Category:	AE
Semester:	II
No. of class week:	12
Lecture/ week:	0 periods
Tutorial/week:	0
Practical/week:	8

Objectives:

- To give students practical skills in general electrical works
- To make students participate in electrical operations

Learning objectives:
By the end of this course students will be able to:

- To participate in different electrical operations.
- To apply electrical skills in solving energy problems.

CONTENTS:

Introduction to safety precautions, domestic installation, protection devices (circuit breakers, fuses etc.), code of practice, electrical distribution for domestic operations, electrical meters, electric lights, motor, generator, transformer, distribution system and planning, motor parts identification and installation, star/delta and delta/star installation of motors, contactors over load and timer relay setting installation, cable sizing according to code of practice, earthing, change over switches and tracing defaults in electric circuits.

Recommended text books: Practical electricity and electronics by J Watson
Assessment: Class work 40%, Examination 60%

CODE: AE 127 TITLE: Project planning and management (45 15 0)

Course code: AE 127
Subject: Project planning and management
Category: AE
Semester: II
No. of class week: 12
Lecture/ week: 3 periods
Tutorial/week: 1
Practical/week: 0

Objectives:
The course will develop managerial skills in students, equip them with knowledge of basic management tools and techniques to solve practical Alternative Energy application-related problems, and develop project management skills.

Learning outcomes

On completion of this subject the student will be able to
- Understand the principals of management and planning of a project.
- Understand and apply essential management and planning tools to small projects.
- Use scheduling techniques during project implementation.

Contents:
Management objectives, responsibilities, principles and environment. Management functions. Management styles.
Introduction to management tools: elements of management economics; financial and management accounting; costing; budgeting and budgetary control. Elements of marketing and marketing management, business management, personnel management, production management, contract management, law of contract. Project Management.
Project planning; impact on organizational planning cycle; matching plans to the organizational strategic plan. Roles in a project team.

Project scheduling: concepts, tools and techniques: bar charts, CPM (Critical Path Method) and PERT (Program Evaluation and Review Technique), site organization and meetings, construction labor, control of work progress, etc.

Management of expectations, change, system evaluation and selection, vendors, consultants, implementation. Case studies.
Recommended text books: Project planning, analysis, selection, implementation & review fourth edition by Prasanna Chandra, project management sixth edition by Paul Burns.

Assessment: Course work 20%, Test 20%, Exam 60%

CODE: AE 128 **TITLE: Introduction to electrical machines (30 15 30)**

Course code: AE 128
Subject: Introduction to electrical machine
Category: AE
Semester: II
No. of class week: 12
Lecture/ week: 2 periods
Tutorial/week: 1
Practical/week: 2

Objectives: To give students the knowledge on the construction and working principles static and rotating machines

Learning outcomes: by the end of this course student will be able to:
- understand the working principle of electrical machines; their application in alternative energies field;

Make solution on the machines that may be useful as it concern alternative energies;
- repair and maintain all machines which are used in alternative energies domain.
- understanding the difference between direct and alternative current machines

Content:
Review on the principle of electricity and magnetism, reluctance and magnetic circuit, properties of magnetic materials.

Transformers
Principle of transformers, equivalent circuit, auto-transformer, calculation of voltage, current; turns ratio, voltage and current transformers.
Single and three phase transformers; parallel operation of transformers.

Direct current machines
Working principle of dc machines, different types of excitation (series, shunt compound and self excitation). Characteristics of generators and motors.

Alternative current machines
1. **Induction machine**: working principle of induction machine, torque-speed characteristics, types of induction machine (squirrel-cage type, wound type), their mode of starting and their constructional feature, equivalent circuits of induction machine, single phase induction motor.

2. **Synchronous machine**: principle of operation, starting method, application, comparison between induction and synchronous machine.

Recommended text books: Electrical power engineering proficiency course by Deutsche Gesell Schaft; Electrical installation principles and practices by J Hyde.

Assessment: Course work 20%, Test 20%, Exam 60%

CODE: AE 129 **TITLE: Technical drawing II (1 0 45)**

Course code: AE 129
Subject: Technical drawing II
Category: AE
Semester: II
No. of class week: 12
Lecture/ week: 1
Tutorial/week: 0
Practical/week: 3

Objective of the course: To make student read and interpret the technical drawings.

Expected output: The students will be able to read and understand the technical drawings and work independently as per provided drawings.

Course content

Topic		Duration
1.	Development and intersections	[1+5]
	1.1. General concept and practical consideration	
	1.2. Development of a right or oblique prism, cylinder, pyramid & cone	
	1.3. Development of a truncated pyramid and cone	
	1.4. Lines of intersection of geometric surfaces	
	1.5. Intersection of lines of two planes	
	1.6. Intersection of prisms and pyramids	
	1.7. Intersection of sphere and an oblique plane	
	1.8. Intersection of cylinder and an oblique plane	
	1.9. Intersection of two cylinders	
	1.10. Intersection of a cylinder and a cone	
2.	Welding and riveting	[1+5]
	2.1. Representing joints and welds for gas , arc and resistance welding	
	2.2. Drawing symbols for welds	
	2.3. Rivets and riveted joint	
3.	Piping diagrams	[2+10]
	3.1. Piping, tubing and types of joints	
	3.2. Specification of threads, fittings and valves	
	3.3. Standard piping symbols	
	3.4. Piping drawings and symbolic diagrams	
4.	Structural drawing	[2+10]
	4.1 Steel construction	
	• Structural steel shapes	
	• Bolted, welded and riveted connections	
	• Detailing practices for structural steel	
	4.2 Wood construction	
	• Timber connections and bolted joints	
	• Detailing practices	

4.3 Concrete construction
- Slab and beam configuration
- Steel reinforcement and prestressing
- Masonry and stone construction

5. Electrical and electronics diagrams [2+10]
   5.1. Standards
   5.2. Types of diagrams – line diagrams, schematic and pictorials
   5.3. Symbols for components
   5.4. Printed circuits
   5.5. Integrated circuits

Notes:
- Allocated time is for lecture as well as for practical classes. Few lectures are conducted for explanation and more emphasis is given on practical exercises in the class.
- It is suggested to design practical exercises on each sub topics so that student learn and practice systematically.
- Drawing board is provided by TCT. Other drawing instruments should be brought by students.

Assessment: Course work 40%, Exam 60%

Reference:
1. Frederick E. Giesecke, Alva Mitchell, Henry C. Spencer, Ivan Leroy Hill, John Thomas Dygdon, James E. Novak, 2002, Technical Drawing, 12 Edition, Prentice Hall.
2. Basic technical drawing, Student edition, 2002, McGraw-Hill.
3. Dhawan R.K., 2005, A text book of machine drawing, S.Chand & Co., New Delhi.
4. Gill P.S., Engineering drawing, S.K. Kataria & Sons, New Delhi
5. Practical exercise sheets

Code: AE 211 **TITLE: Applied sociology (45 15 0).**

Course code:	AE 211
Subject:	Applied sociology
Category:	AE
Semester:	III
No. of class week:	12
Lecture/ week:	3 periods
Tutorial/week:	1
Practical/week:	0

Objectives:

- To give students skills of working with the community.
- To let students know and help in solving community problems.

Learning outcomes:

By the end of this course students will be able to:

- Know methodology of community mobilization.
- Solve community problems related the alternative energy.
- Work with the community.

Contents:

Introduction, Leadership definition, Leadership techniques, dispute/conflict handling techniques(arbitration system),community needs assessment, project selection, project benefits to both individual and community, low keeping and community development introduction to management, qualities of a good manager/leader ,management skills(technical, human and conceptual),management processes(planning, organizing , staffing and directing),government policies in relation to energy sector, rural technology utilization, human and local material resource management, pricing techniques(cost-based and value-based pricing),market research techniques, preparation of business plan.

Questionnaire formulation technique, focus group discussion, appropriate ways of behaving with rural community people.

Recommended text books: Readings in sociology by Warren Kidd; The psychology of bargaining by Bromley Kniveton; Entrepreneurship & small business by Paul Burns

Assessment: Course work 10%, Test 30%, Exam 60%

CODE: AE 212 **TITLE: Design of biogas power plant (45 15 0)**

Course code: AE 212
Subject: Design of biogas plant
Category: AE
Semester: III
No. of class week: 12
Lecture/ week: 3 periods
Tutorial/week: 1
Practical/week: 0

Objective of the course: To equip students with techniques for evaluating biogas energy needs, availability of raw materials and site selection.
To make students able to prepare professional quality solutions and communicate the results of analysis and design of biogas plant effectively.

Expected output: The students will be able to design biogas plant based on the requirements.

Course content

Topic — Duration

1. Basics to design approach and planning concept [11]
   - 1.1 Background and introduction to the need for biogas plant design
   - 1.2 Review on popular biogas plant designs
   - 1.3 Criteria for the selection of an ideal design
   - 1.4 Site selection
   - 1.5 Design parameters for sizing a biogas plant
   - 1.6 Assessment of biogas requirements and available feedstock
   - 1.7 Plant dimensions for different sizes of selected plant
   - 1.8 Building materials for biogas production
   - 1.9 Operation and maintenance of selected bio-digesters
   - 1.10 Loading rate for different plant size
   - 1.11 Calculation of amount of cow dung required to generate 1 m3 of gas per day

2. Design of foundation [4]
   - 2.1 Design of foundation
   - 2.2 Selection of materials (coarse and fine sand, cement, stone chips, gravel)

3. Design of digester and dome [5]
   - 3.1 Design of digester and dome
   - 3.2 Selection of materials (coarse and fine sand, cement, stone chips, gravel)
   - 3.3 Properties of materials (cement, sand, aggregates, water, brick, stone, iron rod etc.)

4. Design of slurry mixing tank [4]
   - 4.1 Design of slurry mixing tank
   - 4.2 Selection of materials (coarse and fine sand, cement, stone chips, gravel)

5. Design of turret and cover [4]

5.1 Design of turret and cover
5.2 Selection of materials (coarse and fine sand, cement, mould)

6. Design of pipe laying in biogas distribution [5]
   6.1 Design of pipe laying
   6.2 Selection of burners
   6.3 Selection of pipes, traps, joints, pressure gauges

7. Design of inlet/outlet pipe, and tank cover [3]
   6.1 Design of inlet/outlet pipe, and tank cover
   6.2 Selection of materials (coarse and fine sand, stone chips, iron/PVC pipes)

References:

1. Karki, A.B., Shrestha, J.N. and Bajgain, S. (2005) Biogas as a Renewable Sources of Energy in Nepal: Theory and Practice. BSP-Nepal
2. Construction Standard, Biogas Model (1999) GGC-2047, BSP-Nepal
3. Course manual – to be prepared

Recommended text books: Technology and application of biogas by Jain Brothers (New Delhi); Energy technology by Dr B.B Parlekar & S RAO

Assessment: Class work 10%, test 30%, Examination 60%.

CODE: AE 213 **TITLE: Design of micro hydro power system (45 15 0)**

Course code: AE 213
Subject: Design of micro-hydropower system
Category: AE
Semester: III
No. of class week: 12
Lecture/ week: 3
Tutorial/week: 1
Practical/week: 0

Objective of the course: After completing this course the student will be able to design the civil components and install the electro-mechanical components of MHP system.

Expected output: The students will be able to describe the main components of MHP system and the benefits from it to the rural development activities in the country.

Course content

Topic		Duration
1.	Introduction to design, planning concepts, evaluation of MHP requirements	[1]
2.	Layout design of civil components of MHP system	[1x9]
	2.1. Intake	
	2.2. Headrace canal	
	2.3. Settling basin	
	2.4. Fore-bay	
	2.5. Penstock	
	2.6. Anchor blocks	
	2.7. Support piers	
	2.8. Expansion joints	
	2.9. The powerhouse	
3.	Selection of mechanical components of MHP system	[4]
	3.1. Selection of turbines and its components	
	3.2. Selection of turbine based on load demand	
	3.3. Valves	
	3.4. Plant efficiency	
	3.5. Turbine sizing	
	3.6. Power output calculation	
4.	Mechanical transmission system	[3]
	4.1. Belts: types, selection, belt tensioning	
	4.2. Pulleys: alignment of pulleys	
	4.3. Couplings: selection of couplings	
	4.4. Safety measures	
5.	Selection of electrical components of MHP system	[2]
	5.1. Generator: type and size	
	5.2. Selection of generators	
	5.3. Factors affecting generator rating	

6. Installation of electro-mechanical equipment [5]
   - 6.1. Machine foundation
   - 6.2. Machinery installation
   - 6.3. Alignment (direct drive, belt drive)
   - 6.4. Installation procedure for the penstock
     - 6.4.1. Joining and adjusting steel penstocks
     - 6.4.2. Joining HDPE (high density polyethylene) penstocks
     - 6.4.3. Laying buried penstocks
     - 6.4.4. Installing expansion joints (bolted type design, welded type design)
     - 6.4.5. Installing the packing
   - 6.5. Control and installation: electronic load controller, ballast load

7. Transformers [4]
   - 7.1. Construction, types, load, uses
   - 7.2. Operation and maintenance
   - 7.3. Safety measures

8. Transmission and distribution line [6]
   - 8.1. Selection of underground or overhead lines
   - 8.2. Selection of high voltage or low voltage transmission
   - 8.3. Sizing of overhead transmission cables
   - 8.4. Installation of transmission and distribution lines
     - 8.4.1. Steps before installing transmission line
     - 8.4.2. Installation procedure
     - 8.4.3. Installation of distribution and service lines
     - 8.4.4. Earthing: system, earth electrodes, pipe electrodes, plate electrodes
     - 8.4.5. Lightning arrestor and installation procedure
   - 8.5. Grid connection

9. Preparation of bill of quantities [2]

Note:
A site visit is suggested to the students to the nearest existing MHP plant and rural community.

Reference:
1. ITDG, 2002, Civil works guidelines for Micro-hydropower in Nepal, ITDG Nepal, ISBN: 99933-95-01-3
2. Boyle, R., 2004, Renewable energy, Oxford University Press, Second Edition, UK
3. Adam Harvey, 1993, Micro Hydro design Manual, Intermediate Technology Publication
4. ICIMOD, 1999, Manuals on MHP for Installation and Commissioning, Maintenance and Repair, Operation and Management.
5. Course manual – to be prepared

Recommended text books: Micro hydro clean water power, Micro hydro design manual (a guide to small scale water power schemes, power plant engineering by Er .R.K Rajput).

Assessment: Course work 10%, Test 30%, Exam 60%

CODE: AE 214 **TITLE: Design of solar energy system (30 15 15*)**

Course code: AE 214
Subject: Design of solar energy system
Category: AE
Semester: III
No. of class week: 12
Lecture/ week: 2 periods
Tutorial/week: 1
Practical/week: 3* (* classes only in week no. 3,6,9,11)
Objective of the course: To familiarize students with designing principles of solar thermal and solar PV systems.

Expected output: The students understand how to design solar thermal and solar PV systems. They will apply solar thermal and solar PV in energy solving problems.

Course content

Topic Duration

1. Concentrating collectors (working principles, construction, basic design criteria and applications). [2]
2. Passive solar heating (working principles, construction, basic design criteria and applications). [2]
3. Solar cooling (working principles, construction, basic design criteria and applications). [1]
4. Solar drying (working principles, construction, basic design criteria and applications). [1]
5. Solar still (working principles, construction, basic design criteria and applications). [1]
6. Types of batteries used in PV system, working principles and their characteristics (life cycle, charge/ discharge stages, specific gravity, balance between PV capacity and battery capacity, C_{10}, C_{20}, C_{50}, C_{100}) [4]
7. Types of solar charge controllers and their working principles. [4]
8. Types of DC-DC converters and DC-AC inverters and their working principles. [2]
9. Characteristics of incandescent, fluorescent, CFL and WLED based lamps (construction, working principles and applications). [3]
10. Measurement of stand-alone solar PV system parameters (charging current, battery voltage), load calculation, wiring diagram of complete system. [3]
11. Application of PV system (pumping, telecommunication, refrigerator, centralised/ grid connected). [1]

List of practical works

1. Determination of thermal efficiency of flat plate solar water heaters. (in week no. 3) [3]
2. Determination of thermal efficiency of solar dryers. (in week no. 6) [3]
3. Series and parallel connection of PV modules to be used with inverter. (in week no. 9) [3]
4. Effect of tracking performance of solar PV home systems. (in week no. 11)[3]

References:

1. Course Manual – to be prepared
2. Douglas M. Considine, Editor in Chief, Energy technology handbook, McGraw-Hill Company (latest edition).
3. Bent Sorensen, 2004, Renewable energy, 3rd edition, Academic Press, An imprint of Elsevier, 84 Theobald's Road, London, WC1X 8RR, U.K.
4. D. Yogi Goswami et al, 1999, Principles of solar engineering, 2nd edition, distributed by Taylor and Francis, 1 Gunpowder Square, London, EC4A 3DE, U.K.
5. Godfrey Boyle, Editor, 2005, Renewable Energy, 2nd edition, Oxford University Press, Oxford in association with The Open University, Milton Keynes, U.K. (www.oup.com)
6. Martin Green, 1992, Solar cells, operating principles, technology and system applications, Prentice-Hall Inc., Englewood Cliffs, N.J. 07632, USA,
7. S.P.Sukhatme, 1992, Solar Eenergy, Eighth Reprint or latest, Tata McGraw-Hill Publishing Company Limited, New Delhi.
8. UNDP, 2000, World Energy Assessment, New York, United Nations.
9. UNEP 2007, UNEP handbook for drafting laws on energy efficiency and renewable energy resources.
10. Laboratory manual

List of equipment/ devices required

1. Solar water heaters (50 litre, 100 litre and 200 litre capacity) [1 each]
2. Tunnel type solar dryers (different size) [1 each]
3. Tracking system (one axis and two axis) [1 each]
4. Tilt angle meter, azimuth & compass [3 Nos.]

Recommended text books: Applied photo voltaic by Earthstar publications Ltd, Solar energy utilization by G D RAI; power plant engineering by Er .R. Rajput

Assessment: Course work 10%, Test 30%, Exam 60%

CODE: AE 215 **TITLE: Workshop technology II (0 0 120)**

Course code: AE 215
Subject: Workshop technology II
Category: AE
Semester: III
No. of class week: 12
Lecture/ week: 0 periods
Tutorial/week: 0
Practical/week: 8

Objectives:

- To provide students with applied bench work skills.
- To provide students with applied plumbing skills.
- To provide students with applied welding skills.

Learning outcomes:
By the end of this course the students will be able to:

- Carryout the necessary activities in bench work, plumbing, and welding.

CONTENTS:
Part I: Introduction to safety precautions, review of hand tools, marking and measuring devices.
Practical exercise: Fabrication of a hot water storage tank, development of sheet metal, cutting techniques, rolling and joining techniques.

Part II: Introduction to safety precautions, plumbing (pipe working processes, pipe fitting, taps and valves, pipe joining, pipe bending, pipe threading, pipe connection and plastic pipes).
Practical exercise: students will do gas distribution piping for domestic applications.

Part III: Introduction to safety precautions, gas welding and its equipments, arc welding and its equipments, brazing, soldering and types of joints.
Practical Exercise: students will do welding while making cylindrical metal objects such as (digesters, water tanks, community cook stoves).

Recommended text books: Practical plumbing by Smith & Curry; bench work practice manual (KIST); welding practice workshop technology by Brian D Smith.

Assessment: Class work 40%, Exam 60%

CODE: AE 216 **TITLE: Biomass and design and construction of cooking stoves (15 0 45)**

Course code: AE 216
Subject: Biomass and design and construction of cooking stoves
Category: AE
Semester: III
No. of class week: 12
Lecture/ week: 1
Tutorial/week: 0
Practical/week: 3

Objective of the course: After completing this course the student will be able to design, construct and test the improved cooking stoves.

Expected output: The students will be able to describe, design and construct the cooking stoves and realize the benefits of improved cooking stoves to reduce indoor air pollution and saving of forest.

Course content

Topic		Duration
1.	Introduction to cooking	[1]
	1.1. Cooking practice in Rwanda	
	1.2. Factors that affects cooking	
	1.3. Problems associated with traditional stoves in cooking	
2.	Fuel used for cooking	[2]
	2.1. Introduction to biomass	
	2.2. Fuel-wood; types, properties and consumption pattern	
	2.3. Charcoal: properties and production methods	
	2.4. Bio-briquettes: properties and production methods	
	2.5. Kerosene: properties, uses	
	2.6. Producer gas: properties and production methods	
	2.7. Biogas: properties and production methods	
	2.8. LPG: properties, uses	
	2.9. Peat: properties and production methods	
3.	Traditional cooking stoves	[1]
	3.1. Types: metal, clay, uses and cost	
	3.2. Merit and demerit of traditional stoves	
	3.3. Construction methods of traditional stoves, material used and cost	
4.	Design of improved cooking stoves	[3]
	4.1. Main components of improved cooking stoves	
	4.2. Merit and demerit of improved cooking stoves	
	4.3. Design principles of improved cooking stoves	
	4.4. Design process: process design, mechanical design, production design	
5.	Construction/ manufacturing of improved cooking stoves	[2]
	5.1. Manufacturing skill	

5.2. Testing at production site
5.3. Cost

6. Efficiency testing of cooking stoves [2]
   6.1. Water boiling test
   6.2. Comparison of efficiency with other types of stoves

7. Environmental and social benefits of improved cooking stoves [2]
   7.1. Conservation of forest
   7.2. Saving of energy and time
   7.3. Promote health condition
   7.4. Reduce indoor air pollution

Practical:

1.	Study of traditional stove: construction, efficiency and demerits	[4]
2.	Construction of improved cook stove (clay) as per design	[6]
3.	Construction of improved cook stove (metal) as per design	[6]
3.	Conduct water boiling test at different types of stoves	[6]
4.	Compare the efficiency of different stoves	[4]
5.	Production of bio-briquettes	[6]

Assessment: Course work 40% Exam 60%

Reference:

1. Course manual
2. www.hedon.info/goto.php/**Improved**Stove
3. http://www.hedon.info/docs/WhatMakesPeopleCookWithImprovedBiomassStoves.pdf
4. www.zenithenergy.com/BioStove.html

List of equipment required:

1.	Weighing machine	(1)
2.	Clay stove: traditional and improved	(1 each)
3.	Metal stove: traditional and improved	(1 each)
4.	Material for making improved cooking stove	(as per design)
5.	Thermometers	(2)
6.	Pots (5 litre capacity/ or 7 litre capacity)	(2)
7.	Fuel-wood	(as per estimate)
8.	Charcoal	(as per estimate)
9.	Bio-briquettes	(as per estimate)
10.	Indoor air pollution meter	(2)

Assessment: Course work 10%, Test 30%, Exam 60%

CODE: 217 **TITLE: Computer aided drawing (30 0 45)**

Course code: AE 217
Subject: Computer aided drawing
Category: AE
Semester: III
No. of class week: 12
Lecture/ week: 2 periods
Tutorial/week: 0
Practical/week: 3

Objectives:

- To give students skills on use of computers in drawing.

Learning outcomes:
By end of this course students will be able to:

- Apply computer in producing different drawings.

CONTENTS:
Fundamental Concepts: Accuracy and speed.
Basic drawing techniques: Geometric primitives (point, line, arc, curves),
Advanced drawing commands, how to edit objects, texts and annotations, points and units, working with layers(blocks and Xrefs,dimensioning and tolerances, attribute creation, attribute editing and extraction,hatching,plotting and view ports. prepare a layout with a Title block.
Layers: Creating view layers, assigning color and line-type to layers, general application of layers.
Object manipulation (rotation, zooming and pan)
2D drafting: orthographic views, arrangement of views, use of projection lines, hatching using predefined pattern.
3D drafting: coordinate system, construction planes, 3D techniques, extrusion, sweep and rotation.
Use of pre defined objects :(e.g. blocks in Auto CAD)
Plotting and printing: setting up a drawing to be printed: using the dialog box, assigning line weights to layers, selecting the part of drawing to print, previewing a print, print layout.

Recommended text books: Use Solid work soft ware

Assessment: Course work: 40%, Exam: 60%

CODE: 218 **TITLE: Project I (0 0 30)**

Course code:	AE 218
Subject:	Project I
Category:	AE
Semester:	III
No. of class week:	12
Lecture/ week:	0 periods
Tutorial/week:	0
Practical/week:	2

Objectives:

- To give students skills on review of literature on topics related to AE.

Learning outcomes:

By end of this course students will be able to:

- Write a technical report based on literature review and field visits on the given topics related to AE.

Assessment: Course work: 100%

CODE: AE 221 **TITLE: Construction work in biogas plant (15 0 60)**

Course code: AE 221
Subject: Construction work in biogas plant
Category: AE
Semester: IV
No. of class week: 12
Lecture/ week: 1 periods
Tutorial/week: 0
Practical/week: 4

Objective of the course: To give students practical skills on biogas plant construction and installation of domestic gas distribution system.
To make students able to test biogas flow and leakages
To give the students operation and maintenance tips.

Expected output: Students will be able to construct biogas plant and solve biogas related problems.
Students will be able to utilize the slurry in proper way.
Students will be able to prepare tender documents.

Course content

Topic — Duration

1. Construction work of biogas plant as per the specifications [3]
   - 1.1 Site selection
   - 1.2 Selection of construction materials
   - 1.3 Method of excavation of the digester pit

2. Design of biogas plant as per the specifications (e.g. Nepali GGC-2047 design) [9]

3. Construction of biogas plant in TCT [48]
   - 3.1 Selection of appropriate site for bio-digester construction
   - 3.2 Excavation as per the selected size and dimension of bio-digester
   - 3.3 Checking the dimensions of the pit
   - 3.4 Construction of round wall of the digester
   - 3.5 Fitting inlet pipe
   - 3.6 Filling the digester with earth/mud and shaping for dome casting
   - 3.7 Casting of dome
   - 3.8 Removing earth/mud from inside the digester
   - 3.9 Making inlet/slurry mixing tank
   - 3.10 Construction of slurry reservoir
   - 3.11 Construction of turret
   - 3.12 Compacting the dome with earth/mud
   - 3.13 Plastering the inside of bio-digester
   - 3.14 Painting the inside of dome with emulsion acrylic paint
   - 3.15 Fitting main gas valve and gas exit pipe
   - 3.16 Pipe fitting to connect gas to burner and lamp
   - 3.17 Fitting of pressure gauze and gas flow meter

References:

1. Karki, A.B., Shrestha, J.N. and Bajgain, S. (2005) Biogas as a Renewable Sources of Energy in Nepal: Theory and Practice. BSP-Nepal
2. Construction Standard, Biogas Model (1999) GGC-2047, BSP-Nepal
3. Course manual – to be prepared

Recommended text books: Technology and application of biogas by Jain Brothers (New Delhi); Energy technology by Dr B.B Parlekar & S RAO

Assessment: Course work 40%, Examination 60%

CODE: AE 222 **TITLE Construction work in solar system (15 0 60)**

Course code: AE 222
Subject: Construction work in solar system
Category: AE
Semester: IV
No. of class week: 12
Lecture/ week: 1 periods
Tutorial/week: 0
Practical/week: 4

Objective of the course: To enable students in installing solar water heaters and solar PV systems.

Expected output: The students will be able to construct and install solar water heaters and solar PV systems in a given locations as per the design and specification provided.

Course content

Topic		Duration
1.	Financial and economic analysis of solar energy (life cycle cost, payback period).	[2]
2.	Economic benefits of solar thermal energy (with practical Examples applicable to Rwanda).	[4]
3.	Economic benefits of solar PV systems (with Examples applicable to Rwanda).	[4]
4.	Procedures for tender document preparation.	[2]

List of practical works

1.	Complete installation and commissioning of a solar water heater system or solar dryers in a given location as per the specification provided (1st batch students are recommended to install SWH at TCT at staff quarter or student hostel)	[24]
2.	Complete installation and commissioning of solar PV systems in a given location as per the specification provided (1st batch students are recommended to install PV systems at TCT to power one of the AE labs).	[24]

References:

1. Course Manual – to be prepared
2. Douglas M. Considine, Editor in Chief, Energy technology handbook, McGraw-Hill Company (latest edition).
3. Bent Sorensen, 2004, Renewable energy, 3rd edition, Academic Press, An imprint of Elsevier, 84 Theobald's Road, London, WC1X 8RR, U.K.
4. D. Yogi Goswami et al, 1999, Principles of solar engineering, 2nd edition, distributed by Taylor and Francis, 1 Gunpowder Square, London, EC4A 3DE, U.K.
5. Godfrey Boyle, Editor, 2005, Renewable Energy, 2nd edition, Oxford University Press, Oxford in association with The Open University, Milton Keynes, U.K. (www.oup.com)

6. Martin Green, 1992, Solar cells, operating principles, technology and system applications, Prentice-Hall Inc., Englewood Cliffs, N.J. 07632, USA,
7. S.P.Sukhatme, 1992, Solar Eenergy, Eighth Reprint or latest, Tata McGraw-Hill Publishing Company Limited, New Delhi.
8. UNDP, 2000, World Energy Assessment, New York, United Nations.
9. UNEP 2007, UNEP handbook for drafting laws on energy efficiency and renewable energy resources.

Equipment required

1. Sufficient number of solar water heaters as per the specifications (at least 200litres SWH).
2. Sufficient number of solar PV Modules, required size charge controller and required size batteries along with accessories (at least 500Wp PV system).
3. Proper tool boxes and required no of mounting structures.

Assessment: Course work 40%, Examination 60%

CODE: AE 223 **TITLE: Construction work in micro hydro power plant (30 0 60)**

Course code: AE 223
Subject: Construction work in micro-hydro power plant
Category: AE
Semester: IV
No. of class week: 12
Lecture/ week: 2
Tutorial/week: 0
Practical/week: 4

Objective of the course: After completing this course the student will be able to prepare the document on construction of MHP and perform repair and maintenance of MHP plant.

Expected output: The student will be able to carry out the construction work, repair and maintenance work of MHP plant.

Course content

Topic		Duration
1.	Hydrology and Site survey 1.1 Preparation for the site survey 1.1.1 Map study of site 1.1.2 Meteorological data analysis 1.2 Site survey 1.2.1 Head measurement 1.2.2 Flow measurement 1.3 Water management	[4]
2.	Revision on System Design 2.1 System layout, intake, fore-bay, channels 2.2 Penstock - materials, joining, sizing, costing and supports	[3]
3.	Review of Electro-mechanical equipment 3.1 Turbine-types, selection of turbines 3.2 Accessories- draught tubes, pumps 3.3 Governing mechanism, specifying the governor, types of governors 3.4 Drive system- direct/ belt, bearings, shaft sizing, balancing 3.5 Electrical power system, selection of power supply systems 3.6 Generators- synchronous / induction 3.7 Switching, transmission and distribution	[6]
4.	Project evaluation and report preparation 4.1 Plant factors, unit energy cost, cost benefit decisions 4.2 Financial analysis 4.3 Capability and demand survey 4.4 Pre-feasibility and feasibility study	[6]
5.	Tender document 5.1 Technical specification 5.2 Cost estimation	[4]

Project Works:
A project work on MHP is given to each student based on Energy Atlas on MHP in Rwanda prepared by Ministry of Infrastructure. The report should consist of MHP system design with the provided data. It is further strengthened with financial analysis including the preparation of bill of quantities and management of the system.

Practical:
The practical classes should be conducted on the demonstration plant in the college. It will consist of the following topics:

1. Commissioning and testing [3]
   - 1.1. Commissioning procedures
   - 1.2. Commissioning and performance test
   - 1.3. Rectifying faults
   - 1.4. Endurance test
2. Maintenance and repair of electro-mechanical equipment [10]
   - 2.1. Valves
   - 2.2. Turbines
     - 2.2.1. Pelton turbine
     - 2.2.2. Cross flow turbine
     - 2.2.3. Tapered locking sleeves
     - 2.2.4. Bearing fitted with tapered adapter sleeves
   - 2.3. Power drive systems for MHP plants
     - 2.3.1. Couplings for direct drives
     - 2.3.2. Belts and pulleys
   - 2.4. Generators [4]
3. Control and instrumental panel
   - 3.1. Instrument for schemes without a load controller
   - 3.2. Instrument for schemes with load controllers
   - 3.3. Protection
4. Maintenance and repair of transmission lines [8]
   - 4.1. Transformers
   - 4.2. Transmission lines
     - 4.2.1. Broken lines
     - 4.2.2. Unequally sagging wires
     - 4.2.3. Leaning poles
     - 4.2.4. Dislodged poles and wires
     - 4.2.5. Service lines and connection
     - 4.2.6. Lightning arresters
5. Survey of the MHP site [3]

Note: Site visits to different MHP plant are suggested.

Reference:

1. ITDG, 2002, Civil works guidelines for Micro-hydropower in Nepal, ITDG Nepal, ISBN: 99933-95-01-3
2. Boyle, G., 2004, Renewable energy, Oxford University Press, Second Edition, UK
3. Adam Harvey, 1993, Micro Hydro design Manual, Intermediate Technology Publication

4. ICIMOD, 1999, Manuals on MHP for Installation and Commissioning, Maintenance and Repair, Operation and Management.
5. Course manual – to be prepared

List of equipment required for demonstration unit of MHP at TCT

1.	Turbine (cross-flow type, output capacity of 3 kW)	[1]
2.	Induction generator (3-phase, 380V, 50 Hz)	[1]
3.	Generator – turbine base frame	[1]
4.	Transmission system (v-belt, pulley)	[1]
5.	Electronic load controller (capacity 4 kW, 380V, 3 phase, 50 HZ)	[1]
6.	Ballast load (capacity 1.35 kW per phase, 230V per phase)	[1set]
7.	LT control panel	[1set]
8.	Local bulb load	[1set]
9.	Centrifugal pump set coupled with 3-phase induction motor	[1set]

Note: The detail specification of equipment will be decided after identifying the location of the demonstration unit based on head and flow rate.

Recommended text books: Power plant engineering by R.K Rajput; micro hydro design manual

Assessment: Course work: 40%, Examination 60%

CODE: AE 224 **TITLE: Entrepreneurship (30 15 0)**

Course code: AE 224
Subject: Entrepreneurship
Category: AE
Semester: IV
No. of class week: 12
Lecture/ week: 2 periods
Tutorial/week: 1
Practical/week: 0

Objectives:
To equip the student with the necessary knowledge, skills and attitudes that will enable him to start, operate and manage a personal or group business enterprise.

Learning outcomes:
On completion of the course the student should be able to:

- Prepare a feasibility study for a business project after its identification and selection
- Identify business opportunities
- Know how to start a small business
- Manage human resources in a business
- Make business decisions
- Explain appropriate leadership styles in business
- Evaluate business risks

CONTENTS:
Entrepreneurship and small business development*:*
Entrepreneurship: Meaning, role and importance, entrepreneurial competencies, functions of an entrepreneur-theories of entrepreneurship, micro and macro level factors that determine entrepreneurship-small business: definition, role and importance ownership structures.
Financing of Small Businesses:
Project (Business) Identification and Selection*:* The process involved in the identification and selection of the project or business, feasibility study and steps involved in preparing a feasibility study.
Need for financial planning-Sources of finance-Capital structure
Small Business Start*:* Business plan preparation, the various ways of starting a small business venture, legalizing business, launching a business enterprise and problems involved
Business Management*:* Management of business enterprise planning-organizing-staffing-leading-controlling.
Materials Management: definition and classification-motives for holding inventory-benefits of holding inventory-objectives of materials management-materials management functions, models of inventory management
Marketing of products: The concept of marketing- problems of marketing-market assessment-market segmentation-branding and packaging-pricing policy-distribution channels.
Production operations management: Location and site issues, plant location, production design, quality control, small business technology.

Recommended text books: Entrepreneurship and small business by Paul Burns; public finance in theory and practice by Musgrave

Assessment: Course work 20%, Test 20%, Exam 60%

CODE: AE 225 **TITLE: Workshop technology III (0 0 120)**

Course code:	AE 225
Subject:	Workshop technology III
Category:	AE
Semester:	IV
No. of class week:	12
Lecture/ week:	0 periods
Tutorial/week:	0
Practical/week:	8

Objectives:

- To give students practical skills in the use of workshop machines (lathe machine, drilling machine, etc).

Learning outcomes

By the end of this course students will be able to:

- Use different workshop machines

CONTENTS: Introduction to safety precautions, working principles of machine tools (lathe machine, shaping machine, milling machine, drilling machine, grinding machine) cutting tools (roughing tools, finishing tools, parting tools, etc), selection of cutting speed, spindle speed and feed calculation, lathe operations(clamping, cutting, adjusting the cutting tool, cutting the face flat, drilling the center hole, parting, knurling, taper turning and boring), milling operations, shaping operations, grinding operations and drilling operations.

Recommended text books: Work shop technology by W.A.J Chapman;

Assessment: Class work 40%, Examination 60%

CODE: AE226 TITLE: Project implementation (0 0 90)

Course code:	AE 226
Subject:	Project implementation
Category:	AE
Semester:	IV
No. of class week:	12
Lecture/ week:	0 periods
Tutorial/week:	0
Practical/week:	6

Objectives:

The Alternative Energy project is intended to give students knowledge on:
The design aspects focusing on the planning and design of a selected system for the utilization of solar, biomass, biogas and hydro power
Technical and economical feasibility studies of alternative energies for the benefit of the society.

Learning outcomes

- The ability to design, plan and implement alternative energy related projects
- The ability to assess the viability and economic benefits of the use of appropriate alternative energy (payback period, net present value, internal rate of return).

Assessment: Course work 100%

5. SUPPORT FOR STUDENTS AND THEIR LEARNING

Teaching and Learning
In order to provide a satisfactory learning support, e-learning tools and resources shall be made available to students, by providing a computer laboratory with full internet connection, to students in this program.

6. CRITERIA FOR ADMISSION

For direct entry, the minimum entry points shall be determined by the RNEC as is done in other higher learning Institutions in Rwanda.
For those no coming direct from ETOs the minimum working experience of two years in any practice related to energy and power is needed and must sat for an entrance Examination set by the college.

7. METHODS FOR EVALUATING AND IMPROVING THE QUALITY AND STANDARDS OF TEACHING AND LEARNING

After the initial validation process, the curriculum of the program shall be reviewed from time to time. An external Examiner with relevant qualifications and experience shall be appointed to the program, and shall make annual review of the curriculum, Examinations, and overall assessment.
Staff development priorities shall include ensuring that all staff teaching in the program have attained minimum required qualification and are fully active researchers. The staff shall be assisted financially to attend further trainings, conferences and workshops when necessary so as to improve their knowledge and skills.

8. ASSESSMENT REGULATIONS

The following regulations will apply for the assessment of the program:

8.1 Assessment of Coursework

- 8.1.1 The coursework shall be conducted in all four semesters of the course
- 8.1.2 Each course module shall be offered and assessed in the same semester and a grade awarded.
- 8.1.3 The minimum pass mark for any course shall be the 50%
- 8.1.5 The coursework assessment shall consist of continuous assessment (tests, assignments), and an Examination. The Examination shall carry a weight of 50% and the continuous assessment 50%.
- 8.1.6 Candidates must obtain at least 40% of the continuous assessment (CAT) to qualify for the final Examination. Candidates failing to obtain 40% of the CAT shall have to repeat the coursework.
- 8.1.7 A candidate who fails in an Examination, but who obtains a minimum overall grade of 40% shall be allowed to write a supplementary Examination.
- 8.1.8 A candidate who fails a supplementary Examination shall be allowed to repeat the course.
- 8.1.9 A candidate who fails in more than half of the subjects in any semester shall be discontinued from studies.
- 8.1.10 A candidate who fails the first sitting Examination of a repeated course shall be discontinued from studies.

8.1.11 No candidate shall be allowed to repeat more than three subjects in any semester.

8.2 Regulations concerning the Project Phase:

8.2.1 At the end of 3rd semester of the Coursework, the candidate in consultation with the supervisor shall formulate a project proposal.

8.2.2 A panel of academic staff in the department (program) shall be formed to review all proposals and make recommendation for the feasibility of the project.

8.2.3 The project will be assigned 6 periods per week for the 3rd semester.

8.2.4 Candidates who finish their project work will be required to present their work in the form of a dissertation report, which must be present according to approved guidelines (format and structure).

8.2.5 The candidates shall finally during the presentation be Examined orally by a panel of at least three staff from the department, including the supervisor.

8.2.6 A candidate who fails in a dissertation project, but who has passed the coursework shall be allowed to repeat it for one semester.

8.3 Final Award

Candidates who successfully defend their project will qualify, upon approval by the College Senate, for the award of a **Diploma in Alternative Energy Technology**.