

# **BACHELOR OF SCIENCE IN RENEWABLE ENERGY TECHNOLOGY AND MANAGEMENT**

## **1.0 INTRODUCTION**

The Bachelor of Science in Renewable Energy Technology and Management is a course developed to produce graduates highly knowledgeable in production and management techniques of Renewable Energy. The areas covered include; hydroelectricity, solar power, geothermal, biomass, wind energy, fossil fuel and nuclear. The course is geared towards equipping the graduates with skills to enable them contribute effectively to the growing global effort to enhance sustainable energy sources. It is designed to respond to the growing emphasis on energy efficiency and renewable energy technologies, and structured to prepare students to understand the scientific principles of renewable energy technology and have the management skills. The graduates will be professionals who will be able to enhance development, extraction and management of energy from renewable sources and promote reduction of dependency on finite energy reserves e.g. oil, coal and gas.

## **2.0 OBJECTIVES**

The overall objective of the programme is to produce skilled, motivated and internationally competitive graduates to work in both private and public energy sector of the economy. The specific objectives of the programme are:

- a) To develop competence in students in applying technological solutions to contemporary energy problems.
- b) To produce students with relevant knowledge and skills in renewable energy development and management.
- c) To provide the students with positive attitude and motivation in energy and environmental conservation.

### **3.0 ADMISSION REQUIREMENTS**

Candidates must satisfy the minimum University entry requirements. In addition they should meet the following requirements:

- ) Have at least a mean grade of C+ in the Kenya Certificate of Secondary Education (KCSE). In addition, candidates are expected to have obtained at least a grade C(Plain) or above in Mathematics, Physics, and Chemistry.

**Or**

- ) Have two principal passes in science subjects in KACE and at least a credit in mathematics.

**Or**

- ) Have Diploma or Higher Diploma in Renewable Energy Technology and Management or any other related discipline from a recognized university or college.

**Or**

- ) Have a related degree from a recognized University.

### **4.0 COURSE STRUCTURE AND DURATION**

- a) The degree shall normally take four academic years of 8 semesters.
- b) Courses shall be offered in units. A course unit is defined as that part of a subject described by a coherent syllabus and taught normally over a period of a semester. It is designated as a total of 42 hours of study in a semester. For this purpose one 1-hour lecture is equivalent to one 2-hour tutorial or 3-hour practical or any combination as may be approved by the Board of the School of Engineering Sciences
- c) Part-time students shall be allowed to take not less than 50% of the courses prescribed for the year.
- d) All courses units will be taught for a total of 42 contact hours, including examinations except industrial attachment which will take 480 hours of practical work in a relevant industry.
- e) Students shall be required to undertake Energy Technology and Management Industrial Attachment of 480 hours in third semester in the third year of study.

### **5.0 CREDIT TRANSFER**

Students may be exempted from some courses by the University Senate on recommendation of the School Board.

## 6.0 EXAMINATIONS REGULATIONS

University Senate Examinations rules and regulations shall apply.

## 7.0 COURSE LISTING

One semester shall comprise minimum of seven (7) units and a maximum of nine (9) units.

## 8.0 COURSE DISTRIBUTION

### YEAR ONE SEMESTER ONE

Course Code	Course Title	Contact Hours		Total Contact Hours	Weight (Unit)
		Lecture	Practical		
<b>TET 3111</b>	Introduction to Renewable Energy and Management	42	0	42	1C
<b>TET 3112</b>	Engineering Drawing I	21	21	42	1C
<b>SCH 3111</b>	Inorganic Chemistry	28	14	42	1R
<b>SMA 3111</b>	Mathematics I	42	0	42	1R
<b>SPH 3111</b>	Physics I	28	14	42	1R
<b>EEL 3115</b>	Communication Skills	42	0	42	1R
<b>SBI 3114</b>	HIV and AIDS	42	0	42	1R
<b>SCS 3111</b>	Computer Organization and Application	28	14	42	1R
	<b>Total</b>	<b>273</b>	<b>63</b>	<b>336</b>	<b>8</b>

### YEAR ONE SEMESTER TWO

Course Code	Course Title	Contact Hours		Total Contact Hours	Weight (Unit)
		Lecture	Practical		

<b>TET 3121</b>	Engineering Drawing II	21	21	42	1C
<b>TET 3122</b>	Energy and Environment	42	0	42	1C
<b>SCH 3121</b>	Organic Chemistry	28	14	42	1R
<b>SMA 3121</b>	Mathematics II	42	0	42	1R
<b>SPH 3121</b>	Physics II	28	14	42	1R
<b>SPH3122</b>	Heat and Thermodynamics	28	14	42	1R
<b>ERP 3125</b>	Social Ethics and Integrity	42	0	42	1R
<b>SLB 3121</b>	Development Studies	42	0	42	1R
	<b>Total</b>	<b>273</b>	<b>63</b>	<b>336</b>	<b>8</b>

### YEAR TWO SEMESTER ONE

Course Code	Course Title	Contact Hours		Total Contact Hours	Weight (Unit)
		Lecture	Practical		
<b>TET 3211</b>	Material Science I	42	0	42	1C
<b>TET 3212</b>	Solid Mechanics	28	14	42	1C
<b>TET 3213</b>	Fluid Mechanics I	28	14	42	1C
<b>TET 3214</b>	Electrical Power Application	28	14	42	1C
<b>TET 3215</b>	Workshop Process and Practice I	21	21	42	1C
<b>SMA 3231</b>	Statistics	42	0	42	1R
<b>SPH 3231</b>	Measurement and Instrumentation	28	14	42	1R
<b>PSP 3214</b>	Geographic Information Systems	21	21	42	1R
	<b>Total</b>	<b>238</b>	<b>98</b>	<b>336</b>	<b>8</b>

**YEAR TWO SEMESTER TWO**

Course Code	Course Title	Contact Hours		Total Contact Hours	Weight (Unit)
		Lecture	Practical		
<b>TET 3221</b>	Engineering Metrology	28	14	42	1C
<b>TET 3222</b>	Material Science II	42	0	42	1C
<b>TET 3223</b>	Fluid Mechanics II	28	14	42	1C
<b>TET 3224</b>	Engineering Surveying	28	14	42	1C
<b>TET 3225</b>	CAD Drafting for Energy Technology	21	21	42	1C
<b>TET 3226</b>	Internal combustion Engines	42	0	42	1C
<b>TET 3227</b>	Workshop Process and Practice II	21	21	42	1C
<b>BBM 3221</b>	Fundamentals of Management	42	0	42	1R
	<b>Total</b>	<b>252</b>	<b>84</b>	<b>336</b>	<b>8</b>

**YEAR THREE SEMESTER ONE**

Course Code	Course Title	Contact Hours		Total Contact Hours	Weight (Unit)
		Lecture	Practical		
<b>TET 3311</b>	Photovoltaic Technology	42	0	42	1C
<b>TET 3312</b>	Hydropower Technology I	42	0	42	1C
<b>TET 3313</b>	Wind Energy Technology I	42	0	42	1C
<b>TET 3314</b>	Steam Plant Engine Technology	42	0	42	1C
<b>TET 3315</b>	Fossil Fuel Power Plant Technology	42	0	42	1C
<b>TET 3316</b>	Biomass Energy	42	0	42	1C
<b>TET 3317</b>	Innovation and Design	42	0	42	1C
<b>TET 3318</b>	Research Methods	42	0	42	1C
	<b>Total</b>	<b>336</b>	<b>0</b>	<b>336</b>	<b>8</b>

**YEAR THREE SEMESTER TWO**

Course Code	Course Title	Contact Hours		Total Contact Hours	Weight (Unit)
		Lecture	Practical		
<b>TET 3321</b>	Petroleum Technology	42	0	42	1C
<b>TET 3322</b>	Geothermal Energy Technology	42	0	42	1C
<b>TET 3323</b>	Nuclear Energy Technology	42	0	42	1C
<b>TET 3324</b>	Solar Thermal Energy Technology	42	0	42	1C
<b>TET 3325</b>	Hydropower Technology II	42	0	42	1C
<b>TET 3326</b>	Wind Energy Technology II	42	0	42	1C
<b>TET 3327</b>	Innovation Design Studio	14	28	42	1C
<b>PES 3324</b>	Sustainable Development	42	0	42	1R
	<b>Total</b>	<b>308</b>	<b>28</b>	<b>336</b>	<b>8</b>

**YEAR THREE SEMESTER THREE**

**TET 3331: 480 Hours - Industrial Attachment**

**YEAR FOUR SEMESTER ONE**

Course Code	Course Title	Contact Hours		Total Contact Hours	Weight (Unit)
		Lecture	Practical		
<b>TET 3411</b>	Electric Power Systems	42	0	42	1C
<b>TET 3412</b>	Energy and Cleaner Production	42	0	42	1C
<b>TET 3413</b>	Energy Conservation and Management	42	0	42	1C
<b>TET 3414</b>	Energy and Climate change	42	0	42	1C
<b>TET 3415</b>	Energy and Built Environment	42	0	42	1C
<b>TET 3416</b>	Research Project I	14	28	42	1C

<b>PES 3411</b>	Environmental Impact Assessment and Audit	42	0	42	1R
<b>PSP 3226</b>	Remote Sensing	28	14	42	1R
	<b>Total</b>	<b>294</b>	<b>42</b>	<b>336</b>	<b>8</b>

## YEAR FOUR SEMESTER TWO

Course Code	Course Title	Contact Hours		Total Contact Hours	Weight (Unit)
		Lecture	Practical		
<b>TET 3421</b>	Energy Trade	42	0	42	1C
<b>TET 3422</b>	Energy Planning and Policy	42	0	42	1C
<b>TET 3423</b>	Energy Economics	42	0	42	1C
<b>TET 3424</b>	Energy and Solid Waste Management	42	0	42	1C
<b>TET 3425</b>	Energy Law and Security	42	0	42	1C
<b>TET 3426</b>	Research Project II	14	28	42	1C
<b>BEP 3441</b>	Entrepreneurship Skills	42	0	42	1R
<b>PSP 3426</b>	Project Planning and Management	42	0	42	1R
		<b>308</b>	<b>28</b>	<b>336</b>	<b>8</b>

**C:** Core course, which is central to the discipline of study.

**R:** required course, which is supportive or beneficial to the programme.

## 9.0 DETAILED SYLLABUS

### YEAR ONE SEMESTER ONE

#### **TET 3111: Introduction to Renewable Energy and Management 42 hours**

Definition of energy and measurements, Types of energy resources available; fossil fuels, nuclear energy, wood fuels, biogas, renewable and non renewable energy sources. Energy conversions. Principles of energy generation and environmental impacts, Energy utilization, conservation, storage and management. Energy supply and demand.

**TET 3112: Engineering Drawing I****42 hours**

Technical drawing; Introduction, aspects, drawing instruments. Paper layout. Lettering and numbering. Geometrical constructions. Dimensioning procedures. Projections: types, orthographic to isometric and vice versa, oblique projections. Intersections of regular bodies. True shapes and development. Auxiliary views. Free hand sketching.

**SCH 3111: Inorganic Chemistry****42hours**

Atomic structure: Bohrs theory. Wave nature of electrons. Quantum mechanical model of the Atom. Quantum numbers. Orbital shapes and energy, Qualitative consideration of the Schrodinger wave equation in deduction of s,p,d,f orbitals. Electron spin and the Pauli's exclusion principle. Hund's rule. Aufbau. Principle and the Periodic table: Periodic trends in atomic properties. Electronegativity, electron affinity and atomic radius. Octet rule. Chemical bonding: Ionic bond, Covalence, Co-ordinate valency, Valence- bond representation, Dipole-dipole interactions. Intermolecular forces. Intra-molecular forces, Van der-Waals radii, Hydrogen bonding. Valence Shell Electron Pair Repulsion (VSEPR) theory. Shapes of molecules. Multiple bond repulsion. Hybrid orbitals. Shapes of alkenes alkenes and alkyne molecules. Sigma and Pi- bonds. Simple MO bonding.

**SMA 3111: Mathematics I****42 hours**

Elementary set theory. Mappings and functions: Definitions, domains, codomains, range and inverses and composition of functions. Trigonometry; Functions, their graphs, inverses, degree and radian measure, sine and cosine formulae, trigonometric identities and equations. Algebra: Quadratic equations. Surds, logarithms and indices. Series: Arithmetic and geometric progressions, Permutation and combinations. Binomial theorem and applications such as approximations, simple and compound interest. Remainder theorem applications to solutions of factorials polynomials. Statistics: Collection and representation of data. Measures of central tendencies and variability. Graphical and axiomatic approaches to probabilities. Tree diagrams probability: Definition, axioms, tree diagram.

**SPH 3111: Physics I****42 hours**



Mechanics and properties of matter; vectors; rectilinear motion; projectile motion, Newton's laws of motion and their applications; composition and resolution of forces; uniform circular motion; Newton's law of gravitation:  $G$  (gravitational constant) and  $g$  (acceleration due to gravity); Simple harmonic motion; Determination of  $g$ ; Conservation of energy and momentum; flow of liquids; Viscosity; Surface tension; Elasticity, elastic gases; Scales of temperature, gas and resistance thermometers; Perfect gas-absolute temperature; First law of thermodynamics, specific heat capacities of gases at constant pressure and volume; Kinetic theory of gases-derivation of the relation for pressure; Mechanism of heat transfer, coefficient of thermal conductivity; Black body, Stefan's law; Sound: equation of wave motion; Velocity of sound in solids and fluids; Waves on a string; Relation between velocity and elasticity of the medium; Ultrasonics and their applications.

**EEL 3115: Communication Skills**

**42 hours**

Study skills; planning study time, making reference, filing notes; preparing for examinations. Library skills: organization; classification, shelving; using reference books, listening in lectures, speeches and instructions, understanding lectures, note taking, speaking skills, asking and answering questions in lectures and seminars, making and defending arguments, agreeing and disagreeing, explaining points clearly, academic reading skills, skimming and scanning, understanding footnotes and bibliographical references.

**SBI 3114: HIV and AIDS**

**42 hours**

Introduction; historical background and magnitude of HIV and AIDS, general organization of the human body, reproduction, immune system (human physiology) and other factors; sex and sexuality; the biology of the human immunodeficiency virus and viral transmission; stages of infection and the development of HIV and AIDS; opportunistic infections; HIV and AIDS prevention and infection control; peer education for HIV; treatment options and vaccine development; blood transfusion and HIV and AIDS; management of HIV and related infections; legal and Ethical Issues in HIV and AIDS; Factors that influence the spread of HIV and AIDS in Africa; case studies in selected countries in Africa; HIV and AIDS as a national disaster impacts; myths and emerging issues on HIV and AIDS.

**SCS 3111: Computer Organization and Application**

**42 hours**

Organization: Introduction to the computer and the notion of a programmable machine. The basic organization based on the von Neumann model. Functional components (CPU, memory, I/O) and their logical organization. Number systems and internal data representation. Concept software and types of software. Components of contemporary personal computer systems from end-user perspective. Application: Classical and contemporary applications of computers. Proficiency in basic computer usage and productivity/office automation applications including word- processing, spreadsheets, e-mail, web, etc. Basic first level security and maintenance issues. Ethical and societal issues.

## **YEAR ONE SEMESTER TWO**

### **TET 3121: Engineering Drawing II**

**42 hours**

Construction of thread forms, cams and gear profiles. Concepts and use of sectioning. Sectional views, elevations and projections. Designation, methods of representation and drawing of various types of fasteners and couplings. Assembly drawing. Jigs and fixtures; design drawing; joints. Free hand sketching.

### **TET 3122: Energy and Environment**

**42 hours**

Environment and environmental impacts of energy production and processing of fossil fuels, conventional power generation, Renewable energy technologies and waste disposal. Environmental impacts of energy transportation; electric power transmission ; energy use. Flue gas filtration and pollutant transport in the atmosphere. Energy and global climate change. Safety and risks of energy sources. Pollution prevention: cleaner production, energy efficiency conservation. Society environmental responsibilities. Quality, safety and health environmental systems regulations (ISO 9000/14000). Scientific and political responses to climatic change.

### **SCH 3121: Organic Chemistry**

**42 hours**

The uniqueness of carbon in the periodic table and catenation. Bonding in carbon compounds including  $sp$ ,  $sp^2$ ,  $sp^3$ , hybridization. Elementary structural elucidation, calculations of empirical and molecular formulae, double bond equivalents. The occurrence, nomenclature structural isomerism, physical and chemical properties of alkanes, cycloalkanes, alkenes, alkynes. Alky

halides, alcohols, carbonyl compounds, carboxylic acids, alkyl amines. Reaction mechanisms: Substitution, elimination.

**SMA 3121: Mathematics II**

**42 hours**

Coordinate geometry and equations of straight lines. Matrices: Definitions, matrix algebra, determinants, transpose, adjoints, inverses and solutions of systems of linear equations using matrix method. Limit continuity. Differentiation and integration of algebraic, trigonometric, exponential functions. Applications of differentiation and integration to rates of change, maxima, minima. Area under curve. 1<sup>st</sup> order D.E and their application.

**SPH 3121: Physics II**

**42 hours**

Electricity and magnetism: Properties of magnetic materials and their uses; Direct and alternating current; Heating effect of current; Thermoelectricity. Domestic appliances: Plugs; Heaters; Electric iron; Cookers; Refrigerators. Optics: Review of mirrors and lenses; Ray tracing; Defects in lenses; Optical instruments; Interferences and polarization. Elementary spectroscopy: Solar spectrum; Spectroscopy of atmospheric gases and biomolecules; Ozone filter; Photo electricity: Kinetic energy of photoelectron; Work Energy levels. Explanation of atomic spectra; X-ray spectra; structure of the nucleus; Radioactivity: application; Introduction to nuclear fission; Fusion and nuclear energy.

**SPH 3122: Heat and Thermodynamics**

**42 hours**

Equation of state: Intensive and extensive variables; Equation of state; Work; P-V diagrams. Heat flow: Heat conduction in solids and gases; thermal conductivity; Convection; radiation-black-body radiation; Stefan-Boltzmann's law. Simple Kinetic Theory: Internal energy; concept of temperature; boiling and vapour pressure. Temperature: Thermodynamic equilibrium; concept of temperature; Temperature scales; concept of heat; absolute zero. The laws of thermodynamics: The zeroth law; the first and second laws of Thermodynamics; Clausius and Kelvin Statements of the second law. Thermodynamic changes: Reversible and Irreversible changes; the Carnot Cycle; Clausius' inequality and entropy; heat engines. Thermodynamic relations: specific heats; equation of state; Maxwell's relations; Examples-liquid film,  $C_p-C_v$ . Maxwell's distribution: Mean speed and mean square; kinetic energy; Equipartition of energy theorem, treated simply.

**SLB 3121: Development Studies****42 hours**

Development studies as an autonomous discipline; the concept of development; an overview of the theories and paradigms of development; the relationship between economic growth and development; science and technology in development; developed and developing countries; issues in development: social, economic and political; actors in development: the state, national and international NGO's, bilateral and multilateral institutions, multinational corporations (MNC's) and social movements.

**ERP 3125: Social Ethics and Integrity****42 hours**

Definitions and concept of ethics; categories of Ethics; National cohesion; Integrity; Unity; Structural Injustices; Ethnicity: Positive Ethnicity, Negative Ethnicity; Peace: Peace Making, peace Building, peace Transformation; Stake Holders in National Cohesion.

**YEAR TWO SEMESTER ONE****TET 3211: Material Science I****42 hours**

Classification of Engineering Materials: Metals, alloys, ceramics, polymers and composites. Structure, crystallography and solidification of material. Atomic structure and bonding: micro and macro structures, influence of bonding on strength. Crystal structure metals. Mechanical properties. Cooling curves. Alloy theory and equilibrium diagrams. Iron properties and methods of production; Iron carbon phase diagrams; types, properties, uses and heat treatment of plain carbon steels; stainless steels and cast iron. Mechanical properties; Ductile-brittle transitions. Fracture, toughness. Strengthening methods. Non-destructive testing techniques. Environmental effects on material; corrosion and photo damage. Thermal, optical and electrical properties.

**TET 3212: Solid Mechanics****42 hours**

Stress and strain; Stress and strain are simple tension, compression and shear. Behaviour of materials under load; load extension and stress and stress-strain curves. Poisson's ratio. Volumetric strain. Working stresses. Safety factor. Elastic constants: Young's modulus of elasticity, bulk modulus, modulus of rigidity. Analysis of: Elastic torsion analysis; design of

shafts and strain energy in torsion. Analysis of closed- coiled helical springs. Theories of failure, Mohr's circle of stress and strain.

**TET 3213: Fluid Mechanics I**

**42 hours**

Properties of fluids: fluid statics: pressure at a point hydrostatic law, measurement of pressure. Force on planes areas immersed in a fluid; horizontal, vertical and inclined positions. Centre of pressure of plane surfaces immersed in a fluid.: vertical and inclined positions. Force on curved surfaces. Buoyancy: stability of bodies immersed in a fluid, liquids in a container subjected to linear acceleration and rotation. Fluid Kinematics: types of fluid flow, flow field (Lagrange and Euler's approaches), path and streak lines, acceleration, equation of continuity. Idea fluid flow: stream function, circulation and vorticity, vortex flow, Laplace equation, flow net.

**TET 3214: Electrical Power Application**

**42 hours**

Medium, low and extra low power circuits, applications and installation. Design, installation, wiring and schematic circuit diagrams. Electrical safety and rules; IEE, KIEE, BS and KBS codes and regulations. Wiring systems: Single and three phase power circuit cable calculations, installation, protection and testing. Call, alarm, signal and remote control circuit application and installation. Domestic circuit and appliances; installation and wiring: power circuits. MIMS and Armoured cable. Illumination calculations and lighting circuits. Rotating machines: connections, starters, starting, load characteristic and protection.

**TET 3215: Workshop Process and Practice I**

**42 hours**

Measurement and inspection: use of dial, slip, limits, small hole and telescope gauges. Use of limit systems. Theory and use of vernier. Internal and external micrometers and accuracy. Core gauges for large holed degree of accuracy. Checking and setting measuring equipment. Test for acceptance or rejection of new and run-out. Work safety. Bench work and marking out; use of marking out table and instruments such as scribes, calipers and height gauge. Bench tools: files, hacksaws, chisels, scrappers and hammers. Soft soldering and brazing, riveting, hand screw cutting. Bench and marking out tools.

**SMA 3231: Statistics**

**42 hours**

Introduction to probability and statistics, Sources and method of collecting data. Classification and processing of data, Frequency distribution. Measures of Location, Central tendency and Dispersion. Skewness and Kurtosis. Correlation and regression analysis classical and axiomatic approach to probability, compound conditional probability. Baye's theorem on probability. Concept of random variables. Theory of errors. Conditional probability. Discrete and continuous random variables. Distribution function including Binomial, Poisson, Normal Gamma, Chi-squared, student's and F distributions. Inferential statistics including, confidence, limits, test of hypothesis, least squares, goodness of fit and linear regression.

**SPH 3231: Measurement and Instrumentation**

**42 hours**

Elements of measurements: Accuracy, precision and sensitivity of instruments. Calibration and errors in measuring instruments. Electrical and mechanical measurements. Analogue and digital instruments. Measurement of current, voltage, resistance, frequency and power AC/DC bridges. Transducers: resistive, capacitive, inductive, optical thermal and piezoelectric, photovoltaic display devices. Measurement of mass, volume and area, time, displacement, speed, acceleration and frequency: strain, force, torque, power and pressure; vibration; temperature and fluid flow.

**PSP 3214: Geographic Information Systems****42 hours**

Definition of GIS, Digital data, points, lines, polygons; vector and raster forms, attributes, interaction and manipulation of data. Data capture: digitizing and editing, scanning. Database creation and management, data analysis: overlays, presentation of information products. Examples of application in planning/management/conservation, water resources, geology. Relations of remote sensing to GIS, GIS exercises.

**YEAR TWO SEMESTER TWO****TET 3221: Engineering Metrology****42 hours**

Standards of measurements; wavelength standards, line and end-standards. System of international standards. Mathematical concepts in metrology; errors, precision and accuracy. Standards; role, legal bases, national and international standards. Linear measurement: vernier, micrometer, height gauge, dial gauge and other gauges commonly used in workshops. Limits, fits and limit gauges. Geometrical and positional tolerance. Angular measurements: levels, sine bar, angle gauges, angle dekkor, dividing heads, clinometer. Comparators; mechanical, optical, electrical, pneumatic. Optical projectors and microscopes. Collimation and collimator, interferometry and interferometers; Laser interferometer. Straightness, flatness and squareness testing; alignment testing. Surface texture: specification, measurement. Screw thread; types errors in threads; internal and external measurements. Screw thread gauges. Gear measurements; involute geometry and gear teeth measurements.

**TET 3222: Material Science II****42 hours**

Ferrous Alloys: Methods of production; iron-carbon phase diagram; types, properties, uses and heat treatment of plain carbon steels; Case hardening; stainless steel. Alloy steels; types, properties and uses.

Cast Iron: Grey, white, ductile and malleable cast iron. Methods of production and properties.

Aluminium and its alloys: Methods of production of commercial aluminium, wrought and cast alloys; properties and uses.

Copper and its alloys: Methods of production of commercial copper, brasses, bronzes and cupro-nickel alloys; properties and uses.

Special alloys: Characteristics and uses of nickel, titanium, magnesium, zinc alloys and refractory metals.

Corrosion and degradation of materials: Oxidation; rates and mechanisms, designing against oxidation: Corrosion; electrochemical nature, types and prevention of corrosion.

**TET 3223: Fluid Mechanics II**

**42 hours**

Similarity and dimensional analysis. Application of dimensional analysis; rise in capillary tube, discharge over a sharp-edged weir, velocity in an open channel, pipe orifice. Model similitude. Bernoulli's equation and its application. Linear momentum equation and its application. Flow measurement: measurement of pressure, velocity and discharge. Laminar flow: Navier-Stokes equations of motion, Hagen-Poiseuille flow along inclined plates, Couette flow in cylindrical co-ordinates, measurement of viscosity.

**TET 3224: Engineering Surveying**

**42 hours**

Introduction to surveying: definition, methods of surveying such as cadastral, geodetic, hydrographic and marine. Engineering survey: mine, topographical, aerial and land. Principles of surveying. Theory of errors: gross, systematic and accidental errors; sources, propagation and minimization of errors. Detailed mapping. Plane table surveying, chain surveying and compass surveying. Ordinary leveling: instruments, procedures and applications, contouring, cross-sections and profiles for highways, drainage, channels, pipelines. Two dimensional plane coordinate system. Traversing: theodolite observations of vertical and horizontal angles, reduction of readings, traversing and adjustments. Total station and its use.

**TET 3225: CAD Drafting for Energy Technology**

**42 hours**

The CAD environment: CAD hardware systems; computer specification, input and output devices. CAD software systems; 2- and 3-dimensional drafting techniques. Fundamentals of CAD drafting techniques. Current industry-standard types such as AutoCAD and Inventor. Three-dimensional computer aided drafting: Basic geometry; Lines, circles, arcs, combining and modifying entities, layers, colour. Inserting text and dimensions. 3-dimensional modelling; wireframe, surface and solid modelling.



Computer Graphics: transformations, translations, rotations. Technical drawing codes and conventions. Sectioning. Assembly drawing. Standard mechanical and electrical components. Process and instrumentation drawing.

Creation or use standard objects to make engineering drawings with AUTOCAD, Merge text and dimensions with drawings generated from AUTOCAD, Make layouts and plot drawings created by AUTOCAD.

**TET 3226: Internal Combustion Engines**

**42 hours**

Internal combustion engines: Functional identification of internal combustion engine components and sub-assemblies; cylinder head, cylinder block, crankcase, piston assembly, connecting rods and their respective construction materials. Basic engine types, test methods and pressure measurements, combustion, ideal cycles and model processes, equilibrium charts, fuel specifications and tests. Engine knock, exhaust analysis, fuels systems, ignition systems, engine performance and supercharger matching. Hands on laboratory work on petrol and diesel engines.

**TET 3227: Workshop Process and Practice II**

**42 hours**

Lathes; types, constructions and functions. Chip formation; types of cutting tools; tool life; tool deterioration and its causes; sharpening of cutting tools and cutting tool angle. Turning; capstan, turret and numerically controlled lathes. Drilling: gang and multi-spindle machines, cutting speeds and feeds, twist and other types of drills, sharpening of drills, working holding methods, drilling jigs and fixtures. Shaping machine; construction and functions, attachments and cutting tools, setting up work piece by use of parallels, angle plates, clamping plates, shims, wedges; correct selection of speeds, feeds and stroke adjustments.

**BBM 3221: Fundamentals of Management****42 hours**

Foundation in management and organizational behavior: surveying theories and practices relating to managerial roles, organizational cultures, fundamental strategic issues, planning, team building, communication, motivation, leadership, decision-making, control, structure and change. Management theories and practices in historical perspective, Managerial roles and principles, Cultures and their impact on organizations, Goal setting, planning, and fundamental strategic issues, Working in teams, interpersonal communication, and motivation, Managerial decision making, Organizational structure and change, Control processes and performance standards, Leadership.

**YEAR THREE SEMESTER ONE****TET 3311: Photovoltaic Technology****42 hours**

Fundamentals of photovoltaic conversion: photon energy, solar cell materials, silicon solar cell technology: purification, crystal growth, module design, polycrystalline and amorphous silicon cells. Other solar cells. Balance of system; structure and installation power conditioning and controls, storage batteries. Photovoltaic applications. Photovoltaic circuit properties and loads. Design of PV systems. Economic analysis of PV systems. Current trends in photovoltaic technology.

**TET 3312: Hydropower Technology I****42 hours**

Streamflow analysis for assessment of hydropower potential of rivers: Applications of Flow Duration Curves and Power Duration Curves. Design flow and reservoir storage capacity, Design flow required, determining power and energy. Civil works: Classification of Hydro schemes, components of a hydropower scheme, design and construction. Turbines: Basic principles, types of turbines and selection. Plant design and installation. Governing. Electricity generation system. Waterwheels, Hydrams. Environmental impacts of a hydro-electric project: hydrological effects, dams and their effects, social effects etc. Economics of hydro and micro-hydro power.

**TET 3313: Wind Energy Technology I****42 hours**

Wind generation and distribution: Wind measuring devices; wind speed analysis; site selection. Wind energy: wind energy converters, energy and power in the wind, power coefficient. Lift and drag forces. Thrust on the turbine (torque). Blade element theory (mechanical power). Electricity generation: the elementary dynamo, generators. Wind pumping: types of wind pumping systems, water requirements and storage, matching the characteristics of windmill and the piston pump, procedure for wind pump sizing . Environmental impacts energy systems. Wind energy economics.

**TET 3314: Steam plant Engine Technology****42 hours**

Power cycles, combined power-heat cycles, net efficiencies; selection of pressure and temperatures; selection of and design of condensers, feed heaters, and de-aerators; selection and design of heat exchange elements of steam generators, combustion mechanisms, fuels, fuel systems; furnace design; auxiliary equipment; control systems; thermal fluids, plant costs.

**TET 3315: Fossil Fuel Power Plant Technology****42 hours**

Introduction: The earth energy flow system. Formation of fossil fuels: petroleum, coal, natural gas. World reserves and distribution. Extraction of fossil fuels. Chemical and physical properties. Refining. Use of fossil fuels. Global demand for fossil fuels. Local, regional and global environmental impacts of fossil fuel exploration and exploitation. Diesel and Gas Turbine Power Plant: General layout of diesel power plant. Fuel, cooling, lubrication and starting system of diesel power plant. Cycles of gas turbine power plant. Performance of gas turbine power plant. Series flow, parallel flow gas turbine plant. Gas turbine combustion chamber. Free piston engine plant. Combined gas turbine-steam turbine plant. Repowering.

**TET 3316: Biomass Energy****42 hours**

Biomass: physical and chemical properties; global use of biomass energy. Bio-energy in Kenya and other developing countries. Sources of fuel wood in Kenya. Non-tree biomass. Fuel wood crisis: causes, consequences, possible solutions. Biomass conversion technologies. Environmental impacts of biomass energy: Deforestation, forest and land degradation.

Environmental and socio-economic benefits of bio energy. Economic analysis of bio energy options. Wood, bio-waste and charcoal burning stoves, stove design and testing methods.

**TET 3317: Innovation and Design**

**42 hours**

Priorities and aims for Design and innovation; Factors in design and innovation. Systems Approach to design. Process Optimization methods. Introduction to Control Theory. Product design analysis, Product creation process, product design process, engineering the product design. Design cycle process. Design obsolescence. Design considerations: Safety and ergonomics, Elements and design, alternatives. Product tests and evaluation; Preliminary tests, Elemental functions and standardization and field tests. Product and test data analysis. Design cycle of innovation and improvement product reporting.

**TET 3318: Research Methods**

**42 hours**

History of scientific theory; paradigm shifts; experimental methodology and the scientific method. Research designs: complete randomization, Randomized block designs: representative Sampling. Proposal writing: statement of the problem, purpose of study, specific objectives; research assumptions; research hypothesis, literature review, experimental methodology design. Analysis of data; student t-test, multiple comparisons, use of computers in data analyses, report writing and presentations.

**YEAR THREE SEMESTER TWO**

**TET 3321: Petroleum Technology**

**42 hours**

Occurrence and distribution Petroleum reservoir rocks, fluid properties and characteristics, calculations of reservoir volume, drill hole, cementing and casing practices, factors affecting bit penetration, borehole measurements and interpretation, formation damage causes and preventions, well complementation, work over and stimulation techniques. Methods of gas and oil recovery, oil well site and transportation systems. Theory of petroleum processing. Offshore operations. Environmental impacts.

**TET 3322: Geothermal Energy Technology**

**42 hours**

Occurrence and distribution of geothermal fields globally. The mining of geothermal heat. Physics of geothermal resources. Thermal fields. Models and types of geothermal reservoirs: hydrothermal dry-steam, liquid-dominated and mixed. Chemistry of geothermal fluids. Geothermal exploration and drilling. Technologies for geothermal resource exploitation: Bore characteristics and their measurements, fluid collection and transmission, electric power generation from geothermal energy. Other uses of geothermal heat. Control and safety of geothermal installations. Economics of geothermal energy, environmental impacts. Geothermal potential in Kenya.

**TET 3323: Nuclear Energy Technology**

**42 hours**

Radioactive decay; Atomic and nuclear structure, Nuclear fission, Thermo nuclear fusion. Nuclear fuel cycle. Harnessing nuclear energy. Types of nuclear reactions and Nuclear materials. Nuclear reactor components: moderator, coolant, control rods, shield. Nuclear power reactors: boiling water reactor (BWR), pressurized water reactions (PWR), high-temperature gas cooled reactor (HTGR), Heavy water reactor (HWR), CANDU, Breeder reactors. Reactor performance characteristics. Reactor control. Pollutants and hazards from nuclear energy generation: green house effect, reactor safety, radioactive emissions from power plants, radioactive waste management, waste heat. Nuclear power economics.

**TET 3324: Solar Thermal Energy Technology**

**42 hours**

Fundamentals of solar radiation: solar radiation trigonometry , solar measurements. Solar collector principles and practices. Photo-thermal conversion surfaces: selective and non-selective, glazing materials, insulation materials. Thermal storage; heat exchangers; solar systems control. Principles of design and operation of flat plate solar collectors, transmission of solar radiation, energy balance analysis, heat transfer and loss analysis. Selection of sub-system components. Principles of design and operation of solar concentrators. Applications of solar collectors. Solar energy storage. Solar process economics. Environmental impacts.

**TET 3325: Hydropower Technology II****42 hours**

Principles of Pelton turbine. Condition of maximum efficiency. Turgo and cross-flow turbines. The Euler turbine equation. Velocity triangles. Principles of Francis and Kaplan turbines. Ideal turbine characteristics, losses. Specific speeds, turbine selection. Unit quantity and performance map. Affinity laws. Draft tube, cavitations. Field study to illustrate turbine sizing and selection. The wells turbine. Characteristics and overall efficiency schemes. Comparison of hydro-turbine technology with steam turbines, gas turbine and firing gas turbine technologies.

**TET 3326: Wind Energy Technology II****42 hours**

Wind turbine control: optimal assessment of cut in, rated and cut out wind speeds. Wind turbine dynamics with induction and synchronous generators. Wind turbine modelling. Rotor Wound Induction Generator (RWIG); equivalent circuit, speed torque characteristics, efficiency and power transfer. Wind farms; planning, electrical design and integration of wind energy into large and small systems. Effect of wind turbulence and wind farm geometry on electrical system voltage flicker. Environmental impact assessment. Design of wind turbine blades. Yawed flow. Unsteady aerodynamics. Vortex wake structure and models.

**TET 3327: Innovation and Design Studio****42 hours**

Design of any renewable energy system, including production drawings and/or prototyping, quantification and costing, construction programming and design report.

**PES 3324: Sustainable Development****42 hours**

Definitions of sustainable development; priorities for development; conditions for sustainable development; the concepts of weak sustainability and strong sustainability; measuring sustainable development. Precautionary principle and Sage Minimum standards; role of technological change; population growth and international trade in sustainable development; sustainable development; sustainable livelihoods; operational principles for sustainable development.

### **YEAR THREE SEMESTER THREE**

#### **TET 3331: Industrial Attachment**

**480 hours**

Minimum of eight weeks of attachment to an appropriate energy industry for hand-on practical training. During the Industrial Attachment, students will work under company supervision. Students will maintain a logbook of daily activities and will be required to submit a comprehensive final report for assessment at the beginning of the following semester. Students will be visited at their work place twice by their Lecturers.

### **YEAR FOUR SEMESTER ONE**

#### **TET 3411: Electric Power Systems**

**42 hours**

Characteristics of DC and AC. Single and Poly Phase circuits and concepts. Power plants. Power generation and synchronization. Power transmission and distribution. Primary and Secondary power transmission systems, line inductance and capacitance, power factor calculation, active and reactive power,. Transmission line models. Faults on power line systems, balanced and unbalanced power lines. Analysis of interconnected systems, power flow problems and interactive solution methods. Power system protection: earthing, protection against lightning and corrosion. Power stability and optimal operation of electric power systems.

#### **TET 3412: Energy and Cleaner Production**

**42 hours**

Fundamentals of cleaner production and cleaner development mechanism, Environment and environmental impacts of energy production and processing of fossil fuels, conventional power generation, Renewable energy technologies and waste disposal. Environmental impacts of energy transportation; electric power transmission ; energy use. Flue gas filtration and pollutant transport in the atmosphere.

#### **TET 3413: Energy Conservation and Management**

**42 hours**

Energy supply: fuels; electricity; co-generation (CHP), handling, storage and preparation; fuel upgrading. Energy conversion systems and losses. Energy saving measures: fuel substitution, heat loss reduction, waste heat recovery, recycling of waste materials, maintenance of conversion systems, process modification.

Economic evaluation of energy conservation measures. Need and approaches to energy management. Energy management structure; motivation; information systems; marketing and investment. Energy assessment: survey; auditing and conservation opportunities. Implementation and monitoring of energy saving measures.

**TET 3414: Energy and Climate change**

**42 hours**

Energy and global climate change. Safety and risks of energy sources. Pollution prevention: cleaner production, energy efficiency conservation. Society environmental responsibilities. Quality, safety and health environmental systems regulations (ISO 9000/14000). Scientific and political responses to climatic change.

**TET 3415: Energy and Built Environment**

**42 hours**

Design criteria for achieving human performance goals in energy-efficient buildings, criteria for the exterior/interior environment, and criteria for architectural, mechanical, electrical and building system components. various energy-conserving strategies shall be evaluated for achieving cost effective, Passive solar energy efficient architecture, Energy-efficient design of a specific building type. Energy demand in built environment, Integrated energy systems for buildings, Energy efficient tall buildings, Optimized architecture and intelligent control strategies Human conform and built environment, Human comfort and occupational behavior, and Intelligent energy efficient buildings.

**TET 3416: Research Project I**

**42 hours**

Developing a research proposal within the field of Renewable Energy Technology and Management of Renewable Energy Systems under staff supervision will be carried out by the student. In this course students will submit a research proposal complete with preliminary designs and present the report before a panel of Departmental examiners.

**PES 3411: Environmental Impact Assessment and Audit**

**42 hours**

Legal principles and institutional framework: EIA as a management tool. Basic concepts; preliminary activities; impact identification (scoping); baseline study; impact evaluation (quantification); mitigation measures; assessment; documentation; decision making; post auditing;



falsehoods surrounding EIA. Strategic Impact Assessments: Social Impact Assessments: Health Impact Assessments: Problems and solutions of EIA institutional arrangements. Nature of environmental auditing; role of environmental auditing in environmental policy process; the need for environmental auditing; tools for environmental auditing; categories of environmental stock; critical and environmental audits. National accounts: problems and resource depletion.

**PSP 3226: Remote Sensing**

**42 hours**

Introduction to geographic information systems and remote sensing technologies, Active and passive remote sensing, Data structures, Map projections and coordinate systems, Processing of digital geographic information, Creation of digital elevation models, Visualization, Mapping of water and environmental features, Digitisation, Soil and land use mapping, Map algebra, Presentation of modelling results, Analysis to generate new information and knowledge, Dissemination of new information and knowledge, GIS as a decision support tool.

**YEAR FOUR SEMESTER TWO**

**TET 3421: Energy Trade**

**42 hours**

Major energy markets and characteristics: oil, gas, electricity. The carbon market: Kyoto protocol, European Union Emissions trading scheme, clean development mechanism, joint implementation, cap-and-trade, carbon trading units, emissions trading. Spot, forward and future markets: Spot, forward and future characteristics, arbitrage valuation of forwards and future, analysis of forward curves and energy prices. Price processes in the energy market: stochastic processes, random behavior of energy prices. Trading energy, risk management in the energy market.

**TET 3422: Energy Planning and Policy**

**42 hours**

Energy investment planning. Tariffication and pricing. Energy and environment; The elements of planning; Dealing with uncertainties, planning period, planning errors; system analysis: econometric models; The optimization approach; Graphical; Analytical methods; simulation models; Inquiry methods; (Analogue) approach; Evaluation and Assessment of Planning methods; New energy Technologies planning.

**TET 3423: Energy Economics****42 hours**

Non-renewable and renewable energy. The effects of higher energy prices. Dependence on imported oil. Energy conversion and the environment: externalities; benefit-cost analysis; environmental standards; environmental costs. Economic and cost analysis, energy investment decision making. Allocation of limited resources. Economics of exploration, distribution and utilization: economic evaluation of resource exploration, fuel transportation and distribution. Economic evaluation of renewable energy systems. Economics of exploration, distribution and utilization . Economic evaluation of energy projects. Power plant: Load duration curve. Load factor, demand factor, capacity factor and Diversity factor. Effect and Methods of meeting fluctuating load. Base load plant and Peak load plant. Selection of generating equipment. Cost of electrical energy. Tariff methods. Performance and operating characteristics of power plant.

**TET 3424: Energy and Solid Waste Management****42 hours**

Types and sources of urban solid wastes, generation rates estimation, composition analysis methods, planning and selection of storage facilities, collection methods, refuse vehicle selection, transport system optimization, waste disposal methods: sanitary landfill planning, recycling, composting, combustion waste, minimization/reduction programmes. Economic and environmental impact of solid waste disposal. Potential solid wastes for energy recovery. Energy recovery technologies: combustion/incineration, pyrolysis, aerobic digestion, gasification, alcohol fermentation, compacting etc. recovery technology choice.

**TET 3425: Energy Law and Security****42 hours**

Energy Act: Institutions as a result of the Act and their functions, International Energy Agency, Global Energy Agreements, Nuclear Energy and Non Proliferation, Role of law in Energy Conservation, Energy Laws and Environment laws, World Trade Law and Renewable Energy. Energy and security scenarios. Concept of energy security, its meaning and uses. Major energy security issues and problems. Global energy reserve. Demand and supply; Energy and politics, Energy-socio-economic interrelationships.

**TET 3426: Research Project II****42 hours**

Carry out research based on the approved research proposal, document the findings, present the research findings before a panel of departmental examiners and submit a completed research project report for final examination.

**BEP 3441: Entrepreneurship Skills**

**42 hours**

Meaning of entrepreneurship. Importance of entrepreneurship in an economy. Basic requirements for starting and running an enterprise. Micro and macro constraints to entrepreneurship development and growth. Government policy on entrepreneurship in Kenya. Enterprise support system in Kenya. The policy framework of the success of East Asian and Israel enterprise success. Technology and Industrial growth: impact of technology on small scale enterprise. Accounting for entrepreneurs. Current key issues in entrepreneurship in Kenya. Case studies of managing small business. Basic taxation for business.

**PSP 3426: Project Planning and Management**

**42 hours**

Concepts of project management; project definitions; project charter; identifying phases; designating milestones; project schedule; tasks and milestones; dependencies; setting and assigning calendars; task durations; task sequence; allocating resources; setting and viewing dates; choosing attributes; adding costs and incomes; printing. Project monitoring; reviews of schedules; adding data; comparisons; checking progress, fine tuning; sub-projects; data search; producing reports; with other productivity tools. Application of computers in project planning and management. Design, technology and procurement. Risk management. Project scope management; Methods of selecting and evaluating projects. Work breakdown structure; network planning and scheduling; schedule control.