

BACHELOR OF SCIENCE IN WATER RESOURCES AND ENVIRONMENT MANAGEMENT

1. INTRODUCTION

The Bachelor of Science in Water Resources and Environmental Management at the University is a course developed to train the water resource managers and environment managers in the water, land and environment sector required to respond to declining water resources and the climate change challenges. Most countries in the developing countries are categorized as water scarce countries. The Republic of Kenya is categorized as water scarce country with 647 m³ per capita compared to the recommended standard of 1000 m³ per capita. Responding to water resources management challenges may not be sustainable if a holistic approach is not practiced that focuses on environment management as well. Integrated Water Resource Management (IWRM) is increasingly being accepted as a viable concept in managing the scarce water resources and the ability of adapting to climate change concerns. Environmental degradation is considered one of the key aspects of declining water resources as major ecosystem habitats are being transformed from their natural state to human settlements with critical environmental imperatives. Understanding the linkages between environment management as well as water resources availability is one of the significant concerns of this degree programme. Student will be equipped with the requisite skills that include theoretical aspects, concepts and analytical skills and practicum to allow them graduate as professional water resource and environment managers required in the water and environment sector.

2. OBJECTIVES

This program will equip students with Integrated Water Resource Management skills required in the water and environment sector for sustainable utilization of the water resources.

The objectives of this program are:

- a) To train students to have competence in different areas of water resource and environment managements such as Integrated Water Resource Management; Watershed Planning, Construction Management, Environmental Planning and Management; as well as applications of Geographical Information Systems,

- Surveying, Civil Engineering, Remote Sensing in resource monitoring, planning and management.
- b) To equip students with necessary knowledge, attitudes, technical and analytical skills applicable in Water Resources and Environmental Management useful in the water and environment sector profession and resource monitoring in development sectors and other service industries in the private, public and community sectors.
 - c) To contribute to Science, Technology and Innovation (STI) programmes for the country, through promotion of appropriate technologies and indigenous knowledge in sustainable natural resource management.
 - d) To equip students with skills in scientific research and writing that will enable them work together with water resource and environment managers as consultants and/or in a consortiums.
 - e) Provide the students with a foundation for continuation into advanced degrees in other fields of water resources and environment management.

3. ADMISSION REQUIREMENTS

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

- a) Must satisfy the entry requirements for admission to the School of Spatial Planning and Natural Resource Management.
- b) Must satisfy the minimum entry requirements for admission in Physical and Biological Sciences, Geography and Mathematics
- c) In addition to 3 a) and 3 b) the applicants must have passes at least C+ in Mathematics (where Physical Science was not offered), Biology C+ and Biological Science B-
- d) The following minimum grades should be attained in the respective K. S. C. E subjects: Geography C+, Mathematics C+, Biology C+ or Biological Science B- or Chemistry C+, or Physics C+ or Physical Science B- and a B- in any one of the social science courses and/or a computer course.

Or

- a) Holders of K. A. C. E with minimum of 2 principals and a credit in O- level.

- b) Holders of relevant Diplomas and Degrees from recognized universities in fields of: Planning, Geographical Information Systems (GIS), Survey, Environmental Studies, Water Resources Management and Engineering Courses and any other related field.

4. EXEMPTIONS AND CREDIT TRANSFER

Students may be exempted from selected courses by senate on recommendations of the School Board.

5. COURSE STRUCTURE AND DURATION

The duration of the Water Resources and Environment Management Degree program shall normally be for a period of four (4) academic years of eight (8) semesters and a maximum of eight (8) years. The program course shall comprise lectures, computer application, laboratory practical, field work, project report, project presentation, industrial attachment as reflected in the course description.

The program is organized to meet the requirement of Bachelor of Science in Water Resources and Environment Management as follows:

- a) All candidates must take core and required courses including field work, project studio, industrial attachment and research project.
- b) Special exemptions may however, be given where a candidate has taken equivalent courses elsewhere as may be the case with transfer students.
- c) The program has a multi-disciplinary nature and therefore borrows from other spatial science disciplines; such as, environment, geography, surveying, engineering, statistics, information technology and social science disciplines.
- d) The courses are offered in units.

A course unit is defined as one hour lecture or a three hour laboratory practical session per semester which gives a total of 42 hours

6. COURSE LISTING

One semester shall comprise minimum courses of 7 units and maximum of 9 units.

7. EXAMINATIONS

- a. The University and the School of Spatial Planning and Natural Resource Management regulations shall apply.
- b. All courses shall be examined during the semester in which they are taken.
- c. The end of semester examination and continuous assessment shall comprise 70% and 30% respectively of the total grade. The research project and project studio are the only exemption to this rule.
- d. Research project and project studio will be marked out of 100%
- e. The Industrial attachment will be marked out of 100%

All final examinations shall be two hours unless specified in the course description.

8. COURSE DISTRIBUTION

FIRST YEAR, FIRST SEMESTER

COURSE CODE	COURSE TITLE	Contact Hours		Total	Weight (Units)
		Lecture	Practical		
PES 3111	Introduction to Environmental Studies	42	0	42	1C
SCH 3111	Inorganic Chemistry	28	14	42	1C
SPH 3131	Physics I	28	14	42	1C
PSP 3111	Introduction to Planning	42	0	42	1C
SMA 3111	Mathematic I	42	0	42	1C
SBI 3114	HIV and AIDS	42	0	42	1C
SCS 3111	Computer Organization and Application	28	14	42	1C
EEL 3115	Communication Skills	42	0	42	1C
SECOND SEMESTER					
PES 3121	Basic Concepts in Environment and Development	42	0	42	1C
PES 3122	Introduction to Atmospheric Processes	42	0	42	1C

SCH 3121	Organic Chemistry	28	14	42	1C
SPH 3121	Physics II	28	14	42	1C
PSP 3124	Surveying	28	14	42	1C
SMA 3121	Mathematics II	42	0	42	1C
SLB 3121	Development Studies	42	0	42	1C
ERP 3125	Social Ethics and Integrity	42	0	42	1C

SECOND YEAR, FIRST SEMESTER

COURSE CODE	COURSE TITLE	Contact Hours		Total	Weight (Units)
		Lecture	Practical		
PES 3211	Environmental Law and Policy	42	0	42	1C
PES 3212	Earth Materials, Physical Process and the Environment	42	0	42	1C
PES 3213	Environmental Pollution and Control I	28	14	42	1C
PWE 3211	Fluid Mechanics I	28	14	42	1C
PWE 3212	Water Resources Technology I	28	14	42	1C
PSP 3213	Research Methods in Planning	42	0	42	1C
PSP 3214	Geographic Information Systems	28	14	42	1C
PSP 3216	Project Planning and Management	42	0	42	1C

SECOND SEMESTER

PES 3221	Society, Poverty and Environment	42	0	42	1C
PES 3222	Environmental Pollution and Control II	28	14	42	1C
PES 3223	Economics of Natural Resources Management	42	0	42	1C
PES 3224	Pollution Process in Tropical Ecosystems	42	0	42	1C
PWE 3221	Fluid Mechanics II	28	14	42	1C

PWE 3222	Water Resources Technology II	28	14	42	1C
PSP 3223	Quantitative Techniques in Planning	42	0	42	1C
PSP 3226	Remote Sensing	28	14	42	1C

THIRD YEAR, FIRST SEMESTER

COURSE CODE	COURSE TITLE	Contact Hours		Total	Weight (Units)
		Lecture	Practical		
PES 3311	Environmental Planning Theory	42	0	42	1C
PES 3312	Indigenous Knowledge in Natural Resources Management	42	0	42	1C
PWE 3311	Water and Environmental Quality Analysis	28	14	42	1C
PWE 3312	Climatology and General Circulation	42	0	42	1C
PWE 3313	Surface Hydrology	28	14	42	1C
PWE 3314	Water Supply and Sanitation I	28	14	42	1C
PWE3314	Water Resources Management Project Studio I	28	14	42	1C
PWE 3316	Wetland Ecology and Conservation	42	0	42	1C

SECOND SEMESTER						
PES 3321	Environmental Education and Extension	42	0	42	1C	
PES 3322	Environmental Planning, Management and Conservation Law	42	0	42	1C	
PES 3223	Scientific and Economic Instruments for Environmental Management	42	0	42	1C	
PES 3324	Economics, Technology and Environmental Degradation	42	0	42	1C	
PWE 3321	Soil and Water Conservation Management	42	0	42	1C	
PWE3322	Water Resources Management Project Studio II	28	14	42	1C	
PWE 3323	Groundwater Assessment, Development and Management	28	14	42	1C	
PWE 3324	Water Supply and Sanitation II	28	14	42	1C	
THIRD SEMESTER						
PES 3331	Industrial Attachment	0	480	480	1C	

FOURTH YEAR, FIRST SEMESTER

COURSE CODE	COURSE TITLE	Contact Hours		Total	Weights (Units)
		Lecture	Practical		
PES 3411	Environmental Impact Assessment and Auditing	42	0	42	1C
PES 3412	Environmental Resource Planning and Management	42	0	42	1C
PES 3413	Disaster Preparedness and	42	0	42	1C

	Response				
PES 3414	Sustainable Development	42	0	42	1C
PES 3415	Environment Management Project Studio I	28	14	42	1C
PES3416	Environmental Institutional Structures and Policy Framework	42	0	42	1C
PWE 3412	Construction Management I	28	14	42	1C
PWE 3413	Research Project I	28	14	42	1C

SECOND SEMESTER					
PES 3421	International Environmental Policy and Law	42	0	42	1C
PES 3422	Environmental Conservation Strategies	42	0	42	1C
PES 3423	Environment Management Project Studio II	28	14	42	1C
PES 3424	Environmental Microbiology	28	14	42	1C
PWE 3421	Wastewater Management	42	0	42	1C
PWE 3422	Irrigation and Drainage Systems Management	28	14	42	1C
PWE 3423	Construction Management II	28	14	42	1C
PWE 3424	Research Project II	28	14	42	1C

FIRST YEAR: SEMESTER ONE

PES 3111: Introduction to Environmental Studies

(42 Hours)

Definition of air, soil and water environments; gaseous, liquid, solid and toxic waste in the environment, fate of radionuclides in the environment; noise pollution; use of fossil fuels; forests; wildlife; fisheries; acidic rain and modification; eutrophication; loss of genetic and

biological diversity; natural and man induced disasters; population growth; desertification; ozone depletion; global warming; ecosystem.

SCH 3111: Inorganic Chemistry

(42 Hours)

Introduction to atomic structure, quantum mechanical atom, chemical bonding, valence shell electron pair repulsion theory for predicting molecular geometry. Their theory of chemical bond formation, Periodic table and period classification of elements with their properties, Transition elements and coordination chemistry, application of valence bond theory to coordination compounds, Chemistry of solids and crystals, States of matter, Different gas laws & kinetic theory of gases, stoichiometry, chemical equilibrium, environmental chemistry.

SPH 3111: Physics I

(42 Hours)

Mechanics and properties of matter; vectors; rectilinear 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.

PSP 3111: Introduction to Spatial Planning

(42 Hours)

Scope of planning; the development of planning thought; society and planning; physical planning as a distinct practice; operation of planning; history of planning in Kenya; planning organizations; urban development and planning; planning in a rural community; participatory approaches in planning.

SMA 3111: Mathematics I

(42 Hours)

Elementary set theory. Mapping and function: 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 equation. Surds, logarithms and indices. Series: Arithmetic and geometric progression, Permutation and Combination. 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.

SBI 3117: HIV and AIDS

(42 Hours)

Introduction: Sex and sexuality. Biology of the AIDs virus. Communicable diseases. HIV and AIDS. Prevention and control of HIV infection. Management of HIV and related infections. Legal and ethical issues in HIV/AIDS. HIV/AIDS as a national disaster.

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.

EEL 3115: Communication Skills**(42 Hours)**

Study skills; planning study time, making references, 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.

SEMESTER TWO**PES 3121: Basic Concepts in Environment and Development****(42 Hours)**

Introduction to Sustainable Development: Population, economic growth and the environment; Agriculture, labour and industry; International economics and the environment. World and National Conservation Strategies. Policy framework and International Initiatives: IUCN, WMO, UNEP, the 1972 Stockholm Conference, Tbilisi Conference of 1977, the Lagos Plan of Action, Cairo Action Plan 1985, the World Commission 1987, the Moscow Congress 1987, the Global Environment Facility 1991, the Rio de Janeiro UN Framework Convention on Climate Change 1992 and the Kyoto Protocol of 1997 and Copenhagen and Mexico Conferences; Environmental Movements the Third World and Kenya.

PES 3122: Introduction to Atmospheric Processes**(42 Hours)**

Origin and structure of atmosphere: chemical composition. Thermal structure; general flow patterns: temperature; pressure; winds and humidity. Relationship between precipitation: clouds; cyclones and anticyclones; atmospheric waves; air masses and fronts. Global climate; applications of Meteorology: Relationship between weather and health; agriculture; economics.

SCH 3121: Organic Chemistry**(42 Hours)**

Introduction to basic principles and techniques of analytical chemistry: Volumetric analysis; gravimetric analysis; ionic equilibria and qualitative group analysis; Introduction to organic molecules: their structure, sources and methods of isolation; simple reactions of aliphatic compounds: alcohols, aldehydes, ketones and carboxylic acids; simple reactions of the benzene ring.

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.

PSP 3124: Surveying**(42 Hours)**

Introduction to surveying (surveying fundamentals and branches): Reference surfaces, Basic measurements in the plane (distances and angles i.e using compass, chains, tapes, EDM, etc); field procedures, calibration, atmospheric effects, accuracy, error sources and their treatment, tachymetry (plane-tabling): Instrumentation, procedures and use: Ordinary Leveling Definitions, basic principles of ordinary and precise procedures. Equipment, Instruments types, measurement adjustments. Methods of leveling. Sources of errors. Application. Contouring, cross-section and profiles, setting out levels.

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. First order D.E and their application.

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.

SECOND YEAR: SEMESTER ONE

PES 3211: Environmental Law and Policy

(42 Hours)

Principles of Environmental Law; development of Environmental Law: international, regional and national; Environmental Laws in Kenya; Introduction to Land Use Laws; Water Law; Energy Conservation Acts and Law; Forest Reserve Laws and Acts; Wildlife Acts and Laws; Fisheries Law and Acts; Public Health Act. Laws of the working environments; Factories Act; the role of National Environmental Management Authority (NEMA) and the Environment Management and Coordination Act. Other relevant Laws, Laws and protection of resources and ecosystems.

PES 3212: Earth Materials, Physical Processes and the Environment (42 Hours)

Earth History: Origin and Evolution of the Earth, Origin of continents, Mountain Ranges and Ocean Basins, Development of the Hydrosphere and Atmosphere, the history of life. The Earth Model – Environmental problems and implications: Interior of Earth, radioactive Earth Crustal features and Processes; Introduction to fossils, their occurrence and uses in Earth Sciences; Earth Resources. Soil erosion and depositional processes; Environmental impacts of soil erosion and deposition; Human role and natural factors in soil and water conservation. Overview of soil and water conservation strategies.

PES 3213: Environmental Pollution and Control I

(42 Hours)

Definitions, sources of pollution, types of pollution. Pollution in air, soils. Pollutants movement, storage and fate in the environment. Acid rain, ozone depletion, climate change and global warming. forest decline, Human dimensions of global environmental change. Noise pollution

and levels and health effects and hazardous waste. WHO guidelines and National standards. Current global environmental situation from United Nations Environmental Programme (UNEP) and relevant environment secretariat in Kenya.

PWE 3211: Fluid Mechanics I (42 Hours)

Introduction to fluid mechanics; fluid properties, dimensions and units. Pressure gauges and manometers. Fluid statics: hydrostatic forces and centre of pressure on plane and curved surfaces. Kinetics of flow: types of fluid flow, continuity equation, velocity and acceleration. Dynamics of fluid flow: equation of motion. Euler and Bernoulli's equation.

PWE 3213: Water Resources Technology I (42 Hours)

Introduction to water resources; global overview. Reservoirs Engineering; planning and investigation, sizing, erosion and sedimentation rate computations and control. Dam engineering: site selection, dam types, stability analysis, dam outlet works. Hydroelectric power plants: hydrologic analysis of river flows for hydropower production.

PSP 3213: Research Methods in Planning (42 Hours)

Principles of scientific research and application in spatial planning and natural resource management; formulation of research design; theory; research strategies; survey; questionnaire administration; observation; documentary and archival sources; bibliography; use of data banks; experimentation; data processing; ethics in research; research funding; budgeting and planning.

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.

PSP 3216: Project Planning and Management (42 Hours)

Introduction to project management in water and/or environment programme; selection of a team and a project, project management and problem solving techniques to include design, construction, test, analysis and documentation of the research project, lecture and field work and laboratory combination, laboratory activities to include goal preparation, research, reporting, team meeting, design reviews and demonstrations.

SECOND SEMESTER

PES 3221: Society, Poverty and Environment (42 Hours)

Relationship between social structure, culture and natural environment; modes of production: cultural system; the impacts on natural environment. Poverty: definition; causes; indicators; poverty and use of natural resources. Policies and environmental degradation; access to natural resources: forests, water, fisheries etc. Laws governing access to natural resources. Poverty and power to control resources. Poverty reduction and environmental conservation: role of trade; state; donor agencies and multinational corporations. Debt crisis and structural adjustment programmes (SAPs) in Africa; Poverty reduction strategies in Kenya: problems; economics; politics and corruption.

PES 3222: Environment Pollution and Control II (42 Hours)

Pollution of water: Indicators: oxygen demand and kinematics of Biochemical Oxygen Demand (BOD) removal. Waterborne diseases. BOD, Chemical Oxygen Demand (COD), Total Oxygen Content (TOC), Solids. Mechanism of pollutant fate in a riverine system. Introduction to mass transport and water quality modeling in a riverine systems. Self cleansing of rivers. Lake pollution, marine pollution and their counter measures. Absorption Isotherms.

PES 3223: Economics of Natural Resources (42 Hours)

Introduction: economics of natural resources and conservation; Inter-linkages between the economy and the environment. Classifications of natural resources; elements of economics approach to natural resource issues: resource scarcity and choice. Economics of natural resource extraction: price or cost based indicators of scarcity; efficiency; optimality and market failure; externalities and public goods. Property rights regime and conservation of natural resources. Renewable and non-renewable resources: a simple optimal resource depletion model; the theory

of optimal resource extraction; the economics of water, fisheries or forestry utilization. Sustainable yield and equilibrium, and effect of interest rate on resource use.

PWE 3424: Pollution Processes in Tropical Ecosystems (42 Hours)

Stress on flora and fauna by tertiary municipal waste water. Effects of acid rain on forest. Eutrophication and ecosystem simplification Control of agricultural runoffs into aquatic ecosystems. Effective municipal waste water treatment. Use of hydrogen peroxide in reduction of air pollutants from industries. Use of bio-indicators in aquatic pollution control. Land pollution and ecosystem degradation.

PWE 3221: Fluid Mechanics II (42 Hours)

Fundamentals of pipe flow: frictional head losses, and loss of energy in pipes. Pipes-networks. Flow in open channels: Classification, steady and unsteady, Steady uniform: Empirical formulae for discharge, economic sections. Steady non-uniform: specific energy, critical flow and its application in flow measurement Hydraulic structures: notches, weirs, spillways; culverts

PWE 3223: Water Resources Technology II**(42 Hours)**

Integrated water resources planning. Water resources planning in arid and semi-arid areas and Drought management. Water harvesting and conservation techniques. Engineering economy in water resources. Fundamentals of simulation/modelling.

PSP 3223: Quantitative Techniques in Planning**(42 Hours)**

Inferential statistics: Hypothesis testing; probability, simple correlation and regression analysis. Probability, time series analysis, bi-variate and multi-variate correlation and regression analysis; analysis of variance; introduction to categorical data analysis; factor analysis; principal component analysis, logit and log-linear models.

PSP 3226: Remote Sensing**(42 Hours)**

Concept and techniques of remote sensing, electromagnetic spectrum, sensors and platforms, multi-spectral, hyper-spectral and thermal sensors, aerial photography, radar and lidar sensors, radiometric aspects of remotely sensed data, geometric aspects of remotely sensed data, image enhancement and visualization, image interpretation and classification.

THIRD YEAR**FIRST SEMESTER****PES 3311: Environmental Planning Theory****(42 Hours)**

Theory of planning and theory in planning. Meaning of planning. Mainstream planning theory; rational comprehensive theory. Planning theory (Jurgen Herbarmas critical theory, Freeman's contribution) Marxism and planning theory. Planning with nature (McHarg). African indigenous knowledge systems and the African social theory of planning. African culture relevant to contemporary spatial planning/development. Indigenous anthropological principles of organizing the living, working/production spaces and networks linking the spaces. Form and character of the built environment. Streams of theory/philosophy from African knowledge systems; African socialism and its application to planning in Kenya, Ujamaa approaches to planning in Tanzania and Common Man's Charter in Uganda. Factors sustaining dual (formal/informal) human settlements and economies in Kenya/East Africa.

PES 3312: Indigenous Knowledge in Natural Resource Management (42 Hours)

Meaning of 'indigenous knowledge'; indigenous African environmental resources management systems. Concept of civil society. Concept of participation and its usage by planners, managers and conservationists in environmental resources use. The role of local communities in developing sustainable land-use strategies; conservation and management issues from widely different geopolitical perspectives: case studies from Africa, Latin America, China, and the US. The concept of stakeholder analyses: case study, synthesis and discussion.

PWE 3411: Water and Environmental Quality (42 Hours)

Analysis Air pollution tests, Noise level tests, Water quality tests: Jar test, acidity test, alkalinity test, hardness test, colour, turbidity, pH and chlorine test, determination of metals. Wastewater tests: BOD, Chemical Oxygen Demand (COD), Total Oxygen Content (TOC), Solids, Bacteriological examination, Nitrates, and Ammonia Tests. Bacteriological examination. Soil Pollution tests.

PWE 3312: Climatology and General Circulation (42 Hours)

Spatial and temporal distributions of the major climatic parameters: Radiation, temperature, pressure, wind. Hydrometeors (precipitation, cloudiness, snow, evaporation, humidity, fog, thunderstorms), energy balance, spatial distribution (zonal, meridional and vertical), temporal components (mean, seasonal, diurnal and inter-diurnal distributions). Regional climate modifications by the mesoscale systems: land/sea (lake) breezes, mountain/valley winds, monsoons systems, microclimatology: influence of the microscale factors - vegetation, soil moisture, land use, air masses - classification and modification. Fronts: types and associated weather. Climatic classification: use of vegetation, water budget, energy balance, Budyko as radiation index of dryness; satellite data and other methods. Regional climatology - Climatology of Eastern Africa. Main features of the atmospheric general circulation; Introduction to atmospheric energetics. Kinetic energy, potential energy, total potential energy and available potential energy.

PWE 3313: Surface Hydrology (42 Hours)

Processes of the hydrologic cycle: evaporation, precipitation, Interception, Infiltration, storage, transpiration, percolation and runoff. Man's influence on the hydrologic cycle. Components of stream flow: direct precipitation; surface runoff, subsurface runoff, ground water flow. Measurement of stream flow: measurement of water level; stream discharge. Relationship between water level and discharge. Horton overland flow. Precipitation analysis: areal, depth and point rainfall measurement. Methods of estimating areal rainfall; Arithmetic mean; Thiessen Polygon and Isohyetal Methods. Analysis of storm precipitation-Depth-Area-Duration. Flooding: causes; effects; hydrographs and flood prediction. Groundwater-soil-water movement water budget. Drainage basins definition. Drainage basins in planning and management. Characteristics of drainage basins. Drainage basin form and structure. Morphometric characteristics of river basins. Runoff measurements. Storm water discharge. Mitigation of storm water. Soil erosion: definition; causes; effects. The Universal Soil Loss Equation (USLE); Mitigation of soil erosion. Sediment yield; transportation; deposition and sedimentation. Management of river basins:

PWE 3214: Water Supply and Sanitation I

(42 Hours)

Sources of water for domestic supply, water uses, water demand projections, water conveyance, service reservoirs and sizing, water treatment systems and processes. Water quality parameters. Waste treatment and disposal for individual household and small communities.

PWE 3315: Water Resources Management Project Studio I

(42 Hours)

Identification of water resource development project: problem definition; setting of objectives; methodology definition; data collection; analysis and report writing; oral presentation of individual and group reports.

PWE 3316: Wetland Ecology and Conservation

(42 Hours)

Definitions, classification and inventory of wetlands. Wetland formation and distribution. Global, regional and national status of wetlands. Wetland biodiversity, succession and their adaptations. Ecological and socio-economic importance of wetlands. Threats to wetlands. Sustainable management and wise use of wetlands and the Ramsar Convention. Community based wetlands management strategies.

SECOND SEMESTER

PES 3321: Environmental Education and Extension

(42 Hours)

Introduction to Environmental Education and Extension (EEE): methods and materials; both formal and non-formal settings. Introduce student to apply specific methods and materials to practical situations. How to gain access to EEE materials and information through web-based, written and personal contacts. Introduction to the history, definition, and philosophy of EEE; Differences between formal and non-formal EEE settings; Environment and Ecology Standards; Models of EEE; Place-based-education laboratories covering: Land, Water Resources, Fauna and Flora. Participatory Environmental Planning (PEP).

PES 3322: Environmental Planning, Management and Conservation Law

(42 Hours)

Introduction to basic concepts and relevant legal terminology for planners and conservationists. Definition of an act of parliament, regulation, Section and Subsection of Act of parliament, rules and customs, nature of municipal/local authority bylaws. Existing statutes relevant to public policy making, administration and involvement of government and local authorities in resource use planning, and urban and regional planning; Land Control Act, Water Act, Agriculture Act, Regional development authority specific Acts. Forest Act. Government Land Act, Trust Land Act. Local Government Act. Nature of local authority jurisdictions. The municipal concept and local government systems; African customary legal process and practices, structures and the notion of private individual and collective community. Concepts of arbitration and contract.

PES 3323: Scientific and Economic Instruments for Environmental Management

(42 Hours)

The role of interdisciplinary scientific instruments in Environmental Impact Assessment, Strategic Environmental Assessment, Life Cycle Analysis, Environmental Auditing; environmental management and decision-making, Environmental Management Systems, Payment for Environmental Services, Ecological Systems Services. Introduction to economic instruments: green taxes, subsidies, financial incentives and disincentives; valuation methods: an overview of environmental valuation techniques, Cost and benefit Analysis as used for environmental appraisal and management: rationale, steps, procedures and aggregation. Case

studies from developing countries: integration of economic and environmental appraisals in decision-making.

PES 3324: Economics, Technology and Environmental Degradation (42 Hours)

Economic principles and the analysis of environmental problems: Classification of the dimensions of degradation and possible technological applications: Useful techniques in the examination of non-renewable resources. Policy analysis and control of resource degradation. The role of economics in technology change, development and environmental impact: Economic and social cost of technology assessment and development: Intermediate technology, appropriate technology; labour versus capital intensive technology in industrial and agricultural inputs and outputs: The role of indigenous technology in resource conservation: Technology and Economics in Environmental degradation-a concluding model.

PWE 3321: Soil and Water Conservation Management (42 Hours)

Overview of Kenyan soils, landscapes, and precipitation patterns. Soil erosion by water and wind: processes, mechanics, factors influencing assessment, measurement and modeling. Methods of soil conservation: control of erosion and sedimentation. Design and construction of soil and water conservation structures. Soil and water conservation strategies in different eco-regions and in irrigation schemes. Effect of land management on stream flow, storm flow, water quality, quantity and timing of flows. Role of vegetation in erosion control. Environmental impact analysis of deforestation. Reducing erosional impacts of roads and other development. Strategies, approaches and systems in integrated watershed management. Soils, forests, land management, wetlands and their relationship with floods.

PWE 3315: Water Resources Management Project Studio II (42 Hours)

Identification of water resource development project: problem definition; setting of objectives; methodology definition; data collection; analysis and report writing; oral presentation of individual and group reports.

PWE 3323: Groundwater Assessment, Development and Management (42 Hours)

Hydrologic cycle and processes. Soil properties, soil water retention, zone of aeration and zone of saturation. Generalized Darcy equation of flow through porous media. Flow equations for confined and unconfined aquifers, well hydraulics. Design, construction and performance of wells. Environmental issues: groundwater quality, water logging and drainage, salt water intrusion, land subsidence, groundwater contamination and remediation. Natural and artificial recharge of groundwater. Conjunctive use of surface and groundwater. Introduction to groundwater modeling and its role in regional aquifer development and management.

PWE 3222: Water Supply and Sanitation II

(42 Hours)

Introduction to waste water, sources of waste water, Waste characteristics: physiological, chemical, biological characteristics, Elementary microbiology; growth kinetics, microbiology processes; Treatment systems: conventional, ponds, Constructed wetlands. Treatment processes: primary, secondary and tertiary. Treatment of sludge and sludge liquors, unit processes of physical, chemical and biological treatment of waste water. Re-use of sewage and industrial waste management.

THIRD SEMESTER

PES 3331: Industrial Attachment

(42 Hours)

Students to be attached to water and environmental agencies, conservation agencies, research stations, industries, or any other institutions for a period of 14 weeks, during which the students will be expected to acquire first-hand experience of practical, real-time activities through active participation and involvement. Academic members of staff will visit each student at their places of attachment at least once every four (4) weeks for on-the-spot evaluation. Each student will submit a written report on his or her attachment.

FOURTH YEAR

FIRST SEMESTER

PES 3411: Environmental Impact Assessment and Auditing

(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.

PES 3413: Environmental Resource Planning and Management (42 Hours)

Concept and definition of resource. Theory and principles of resource use; planning for the development and use resources. Concept of sustainable resource development. The organization of community and formal institutions in management of natural resources; water, agricultural land, nature and destitution of forest resources, critical evaluation of wildlife, coastal and inland wetlands, cultural sites, artifacts and historical material as community resources. Role of agricultural land: the national economy, goal of agricultural production: distribution and potential of water and agriculture land resources; implication to food production, drought, famine, other natural disasters; supply of industrial raw materials. Nature of community institutions and organizations for the planning, development and use of natural resources; co-operative agricultural economy, community water projects.

PES 3313: Disaster Preparedness and Response (42 Hours)

Definition of concepts; A global perspective of disaster studies: Occurrence of disasters in Africa: Planning for disasters; Anticipated and the unexpected disasters: Acts of terrorism, famine, floods, earthquakes and wars. Disaster preparedness in developing countries, including Kenya. Emergency relief services. Perceptions of victims: Relief operations, logistics in disaster management and reconstruction. The role of bilateral organizations, NGOs and CBOs in disaster response and management. Case studies of local, national and international organisations in responding to disasters: success and failure cases.

PES 3323: 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.

PES 3414: Environment Management Project Studio I (42 Hours)

Identification of Environment management project: Identification of rural development project: problem definition; setting of objectives; methodology definition; data collection; analysis and report writing; oral presentation of individual and group reports.

PES 3415: Environmental Institutional Structures and Policy Framework (Water) (42 Hours)

Principles of Environmental policy: Objectives of environmental institutions: Policy frameworks in environmental planning and management: Institutional structures and policy framework on trans-border issues and from a global perspective: Variety of contemporary issues within the local politics and governance context. Nature of a healthy community and related environmental concerns: Land use; economic development, community health, transport, and public participation. Comparative studies: Selected case studies from developing and developed countries.

PWE 3412: Construction Management I (42 Hours)

Overview of construction developments: Role of construction in development, types of construction. Applicable regulations in construction. Construction and environment. Types and sources of materials for construction. Plants and equipments in construction. Monitoring and control in construction. Role of stakeholders in construction.

PWE 3413: Research Project I (42 Hours)

Identification of a small-scale urban or rural project in water and/or environment; description of project; problem identification; evaluation of implementation; preparation of project report. Documentation; decision-making; post auditing; falsehoods surrounding EIA; problems and solutions of EIA, institutional arrangements.

SECOND SEMESTER

PES 3421: International Environmental Policy and Law (42 Hours)

The application of international legal instruments in environmental protection and regulation. The protection of the atmosphere: acid rain, ozone depletion and global warming. The control of marine pollution, the protection of the local and global commons: pastureland, dam Antarctica and the regulation of waste management. The enforcement of international environmental law and its challenges.

PES 3412: Environmental Conservation Strategies (42 Hours)

Concept of environmental conservation; Difficulties in conservation; Conservation and environmental institutions. Social and ecological demands on environmental systems. General class of policy tools; Environmental policy process and conceptual framework. Defining natural resource or environmental problems and issues; aggregating interests; agenda-setting; formulating and selecting alternative solutions; implementation and evaluation stages; roles of lobbyists, legislature, executive branch, and other actors.

PES 3414: Environment Management Project Studio I (42 Hours)

Identification of Environment management project: Identification of rural development project: problem definition; setting of objectives; methodology definition; data collection; analysis and report writing; oral presentation of individual and group reports.

PES 3422: Environmental Microbiology (42 Hours)

The isolation, staining, microscopic examination and culture of bacteria. Bacterial growth and nutrition. The effects of environmental factors on bacterial growth and survival. Bacterial classification. Structure and replication of bacteriophage. Bacterial diseases: their transmission and control. The immune response. Control of micro-organisms. Industrial microbiology with reference to industrial and agricultural wastes.

PWE 3421: Wastewater Management**(42 Hours)**

Wastewater characteristics: physical, chemical, biological characteristics of wastewater. Wastewater sources. Wastewater reduction. Estimating wastewater flow rates from water supply data. Wastewater. Design for Waste water Structures: Constructed wetlands; Ecological sanitation and other Appropriate Technologies.

PWE 3423: Irrigation and Drainage Systems Management**(42 Hours)**

Sources of irrigation water: Surface and ground. Irrigation types and system layouts. On farm water control structures. Irrigation water requirements: critical points, evapotranspiration, soil and water potential, irrigation water quality Determination of soil suitability for crops; pH value, physical and chemical composition of soil. Irrigation water requirement: critical points, Management Allowable Deficit. Environmental impact of irrigation practice. Leaching requirements. Drainage: layouts, drain types, design and maintenance. Planning and Design for Large scale, small scale and appropriate technologies in irrigation projects.

PWE 3424: Construction Management II**(42 Hours)**

Construction project planning: Time, cost and human resource planning methods. Construction implementation management: construction cost estimation, cash flow projections and cost control. Construction contracts: types and contract documents, parties in construction contracts and their roles. Tendering procedures. Claims and arbitration. Labour issues in construction. Handing over procedures of completed works.

PWE 3413: Research Project II**(42 Hours)**

Identification of a small-scale urban or rural project in water and/or environment; description of project; problem identification; evaluation of implementation; preparation of project report. Documentation; decision-making; post auditing; falsehoods surrounding EIA; problems and solutions of EIA, institutional arrangements.