UNIVERSITY OF NAIROBI

COLLEGE OF BIOLOGICAL AND PHYSICAL SCIENCES

SCHOOL OF PHYSICAL SCIENCES

DEPARTMENT OF METEOROLOGY

REGULATIONS AND SYLLABUS

FOR

THE DEGREE OF

DOCTOR OF PHYLOSOPHY IN CLIMATE CHANGE SCIENCE (Ph.D CCS)

September, 2015

REGULATIONS AND SYLLABUS FOR THE DEDREE OF DOCTOR OF PHILOSOPHY IN CLIMATE CHANGE SCIENCE (CCS)

1.0 INTRODUCTION

There is a growing need to improve the general understanding of climate information to better serve societal needs. Many countries are addressing the challenges of climate services through the Global Framework for climate services (GFCS) driven by the World Meteorological Organization (WMO).

Kenya's Constitution of (2010) guarantees every Kenyan citizen the right to access information held by the state (Chapter Four of the Constitution). The state covenants to publish and publicize any important information affecting the nation. In addition, Chapter Five stipulates that the state shall eliminate processes and activities that are likely to endanger the environment. Climate Change poses a significant threat to the society, environment and economy both at present and in the future. Therefore, the provision of climate change information will have far reaching implications on Kenya's national development agenda.

Kenya Vision 2030, the country's development blueprint covering the period 2008 to 2030, aims to transform Kenya into a newly industrializing, "middle-income" country providing a high quality life to all its citizens by the year 2030". The economic, social and political pillars of Kenya Vision 2030 are anchored on Science, Technology and Innovation (STI). Several "flagship" projects have been identified and are being implemented. They are expected to take the lead in generating rapid and widely-shared growth. For instance, Weather modification flagship project is envisaged to act as a basis for rainfall enhancement and consequently providing improved availability of the much needed fresh water for rapid economic transformation. Another flagship project is the rehabilitation of the five water towers (i.e. Mau Escarpment, Mt. Kenya, Aberdares Ranges, Cherangani Hills and Mt. Elgon).

Climate change has been recognized as a developmental issue which if not urgently addressed, may impede the gains expected from some of the proposed flagship projects in the Vision 2030. The Kenya National Climate Change Response Strategy (2009) identified the need to train skilled personnel in Climate Change Science for sustainable national development. One of the key components of this strategy is capacity building including research.

The PhD programme seeks to contribute to the national and global initiatives of responding to climate change effects through capacity building in the four broad components of Climate Change Science: Monitoring; Attribution; Mitigation; and Adaptation. This programme is unique in its coverage and is designed to cover a wide range of knowledge and skills required to address the challenges of regional and global climate change and sustainable development.

It also provides an in-depth study of the four key areas above and their interlinkages, drawing upon the internationally recognized teaching, research and consultancy expertise of the multi-disciplinary team of lecturers drawn from many disciplines from within the university, plus visiting lecturers from industry.

The PhD programme in Climate Change is designed to provide students with advanced theoretical and practical knowledge in Climate Change Science. The programme is designed to meet the needs of those graduates seeking careers in the fields such as Climate Change Science; Modeling; Climate Risk Management and research in Climate Change science. The objectives of the programme shall be to impart students with:

(i) Advanced knowledge in climate change science and develop competences in the applications of climate change science
(ii) Skills to conduct advanced research in climate change issues and disseminate research findings.

2.0 ADMISSION REQUIREMENTS

2.1 The Common Regulations for the Degree of Doctor of Philosophy (PhD) in the University of Nairobi and in the School of Physical Sciences shall apply.

2.2 The following shall be eligible for admission:

2.2.1 A holder of a Master's Degree in Climate Change, or its equivalent from the University of Nairobi or any other institution recognized by Senate.

3.0 CREDIT TRANSFER AND EXEMPTIONS

3.1 A candidate may be exempted from some courses and credit transferred from an approved institution subject to the following conditions:

(i) Request for exemption shall be made in writing, on admission to the Director, Board of Postgraduate Studies (BPS), University of Nairobi and must be accompanied by officially endorsed supporting documents, including the syllabi for the relevant course(s) done at the same level.
(ii) The University of Nairobi reserves the right to administer an appropriate test, through respective departments in order to determine whether the exemption should be granted.
(iii) Application for exemption shall be considered only after the payment of an exemption fee, as may be prescribed.
(iv) The courses on which such exemptions are sought shall not exceed one third of the total number of units registered.

4.0 COURSE STRUCTURE AND DURATION

4.1 The programme shall last for a minimum period of eighteen (18) months and a maximum of five (5) years.
4.2 The programme shall be offered by course work, examinations and thesis.
4.3 The course work shall be conducted through lectures, discussion groups, practicals, seminars and assignments
4.4 Continuous assessment shall comprise tests, assignments, practicals, field work and term papers.
4.5 The candidate shall be required to take at least six (6) taught course units except where exemption has been permitted.
4.6 The candidate shall be required to take 4 core course units and at least 2 electives
4.7 The taught courses shall be covered in a minimum of one semester and a maximum of three (3) semesters each of fifteen (15) weeks.
4.8 Candidates shall be required to take at least two (2) course units in each semester.
4.9 A candidate shall be required to write a thesis equivalent to 8 units. The thesis must target a specific area of application of climate change science
4.10 The School may require the candidate to attend such a course or courses as may be considered appropriate.

5.0 MODE OF DELIVERY

The program will be offered under two modes; Face to Face and through Open and Distance learning for students who cannot attend regular University program.

5.1 Face to Face:

5.1.1 The course shall run for a minimum of six semesters and a maximum of twelve semesters of fifteen weeks each.
5. 1.2 The course shall consist of six taught course units, and a Thesis, which shall constitute sixteen (16) units. A student will have taken twenty two (22) units in total.
5.1.3 The course shall consist of course work, examination and a thesis
5.1 .4 The students shall be required to take a minimum of two (2) units and a maximum of six (6) Course units in a semester
5. 1.5 Each course unit shall be taught for sixty hours (60) consisting of lectures and tutorials
5.1.6 The thesis shall be equivalent to sixteen course units, and shall be undertaken after the course work.

5.2 Open, Distance and e-Learning:

This delivery mode will use various media, including print and electronic, and independent study.

5.2.1 The main medium of instruction shall be well-designed printed self instructional study modules. With the inclusion of interactive devices and self-tests, these modules will provide students with great learning opportunities.

5.2.2 The modules will be supported by technology mediated learning materials which include audio compact discs and e-learning materials available on e-platforms such as Module.

5.2.3 There will be limited face-to- face sessions conducted on campus or other identified study centers in the regions. These sessions will be used by lecturers to introduce and provide overviews of the courses at the beginning of the semesters and at mid-semester, to provide clarifications on issues raised by the learners. The end of semester sessions will be used for revisions before examinations.

5.2.4 Students will be supported through the University of Nairobi regional study centers where access to information through computers will be provided.

5.2.5 After registration, students will be given orientation on distance learning. Specifically, orientation in studying at a distance will provide students with study skills, reading skills, time management techniques, handling of assignments and general guidance and counseling.

6.0 COURSE OUTLINE

Core Courses		
CODE	**TITLE**	**HRS**
SCC 801	Climate Change Monitoring and Attribution	60
SCC 802	Socio-Economics and Governance issues in Climate Change	60
SCC803	Philosophy of Climate Change	60
SCC 804	Advanced Research Methods and Techniques	60
Electives		
SCC 805	Integrated Modelling and Assessment of Climate Change on Ecosystems and Biosystems	60
SCC 806	Integrated Climate Modeling and Climate Projections	60
SCC 807	Environmental Monitoring and Observational Techniques	60
SCC 808	Climate Change Response Strategies	60
SCC 809	Climate Change and Energy Resources Technologies	60
SCC 810	Climate Change, Urbanization, Land Use and Development	60
SCC 811	Climate Change, Agriculture and Food Systems	60
SCC 812	Climate Change and Water Resources	60
THESIS		
SCC 820	PhD. Thesis	960

7.0 EXAMINATION REGULATIONS

The common regulations governing examinations for PhD degree in the University of Nairobi, shall apply.

7.1 Written examinations

7.1.1 A candidate shall not be allowed to sit any examination unless he or she has attended at least two thirds of the total lecture hours.

7.1.2 Each unit shall be examined by a three hour written examination at the end of the semester during which the course is offered.

7.1.3 The end of semester examination shall constitute 60% of the total marks in each course unit while the continuous assessment shall constitute 40%. Continuous assessment shall comprise of assignments, tests, term papers and practical where applicable.

7.1.4 The Pass mark for each course unit shall be 50% and the grading shall be as follows:

Class	Mark (%)	Remark
A	70-100	PASS
B	60-69	PASS
C	50-59	PASS
D	Below 50	FAIL

7.1.5 The candidate shall be allowed to proceed to do research after passing all course units.

7.1.6 A candidate who fails in up to three units may be allowed to sit for supplementary examinations in the failed unit(s).

7.1.7 The maximum score for a supplementary examination shall be 50%.

7.1.8 A candidate who fails in more than three units shall be discontinued.

7.1.9 A candidate who fails in the supplementary examination or has failed to complete the prescribed courses within the prescribed time, shall be discontinued.

7.2 Examination of the Thesis

7.2.1 Regulations governing the examination of thesis of the Board of Postgraduate Studies in University of Nairobi shall apply.

7.2.2 The research proposal shall be developed during the first year of study. However, the candidate shall be required to pass coursework before embarking on research.

7.2.3 The thesis topic shall be agreed upon between the candidate and the approved academic supervisors.

7.2.4 Upon successful completion of course work, a candidate shall carry out supervised thesis research in his/her chosen area of specialization

7.2.5 Each candidate shall be required to present a minimum of two seminars in the course of their research work.

7.2.6 At least three (3) months before a thesis is submitted, a candidate shall give notice in writing to the Director of the Board of Postgraduate Studies through Chairman, Department of Meteorology and the Dean, SPS.

7.2.7 The thesis shall be examined through written work and oral presentation. The written thesis shall be examined by two internal examiners and one external examiner, followed by oral presentation/examination to a Board of Examiners

7.2.8 The thesis shall be marked pass, pass with correction, pass with major correction, fail or discontinuation.

7.2.9 Candidates shall be expected to show evidence of submission or acceptance of at least two publishable papers to peer reviewed journals before defending the thesis and graduating.

7.2.10 A candidate who fails in the thesis shall be allowed to re-submit once.

7.2.11 A candidate shall be required to re-submit the thesis within a period of twelve months and shall be discontinued after failing in the re-submission.

7.3 Examination Schedule: course units

LEVEL AND SEMESTER	COURSE CODE	COURSE TITLE	PAPER
YEAR 1			
SEMESTER I (*Core*)	SCC 801	Climate Change Monitoring and Attribution	1 x 3Hours
	SCC 802	Socio-Economics, Political and Legal Issues of Climate Change	1 x 3 Hours
	SCC 803	Philosophy of Climate Change	1 x 3 Hours
	SCC 804	Advanced Research Methods and Techniques	1 x 3 Hours
SEMESTER II (*Electives*)	SCC 805	Integrated Modelling and Assessment of Climate Change on Ecosystems and Health	1 x 3 Hours
	SCC 806	Integrated Climate Modeling and Climate Projections	1 x 3 Hours
	SCC 807	Environmental Monitoring and Observational Techniques	1 x 3 Hours
	SCC808	Climate Change Response Strategies	1 x 3 Hours
	SCC 809	Climate Change and Energy Resources Technologies	1 x 3 Hours
	SCC 810	Climate Change, Urbanization, Land Use and Development	1 x 3 Hours
	SCC 811	Climate Change, Agriculture and Food Systems	1 x 3Hours
	SCC 812	Climate Change and Water Resources	1 x 3 Hours
YEAR 2 and 3 *(Core)*	SCC 820	Ph.D Thesis	Oral Examination

8.0 DEGREE AWARD

The name of the degree to be awarded shall be Doctor of Philosophy in Climate Change Science (PhD CCS).

9.0 COURSE DESCRIPTION

SCC 801: Climate Change Monitoring and Attribution

Course Objectives:

Provide in depth Knowledge of the climate change science is the key to modeling climate and attribution.

Learning Outcomes:

At the end of the course the student should be able to:

1. Demonstrate a deeper understanding of the physics behind climate change
2. Use the General Circulation model to simulate the future climate projections under various scenarios
3. Demonstrate a sound knowledge of climatological data observation practices

Course Contents

Advanced concepts of the physical science of climate change: Climate Change debate; Natural and Anthropogenic drivers of Climate Change; Direct observations of recent Climate Change; Climate Change Attribution. Paleoclimate; Different climate change models and scenarios in relation to future climate change projections: General Circulation Models; Regional Climate Models; and Climate Chemistry Models.

SCC 802: Socio-Economic, Political and Governance Issues in Climate Change

Course Objectives:

Provide in advanced Knowledge and skills of the Socio-Economic dimensions of, and Legal issues in, Climate Change climate science in the context of Mitigation and Adaptation.

Learning Outcomes:

At the end of the course the student should be able to:

1. Apply advance socio-economic concepts and methods to evaluate socio-economic dimensions of climate change
2. Synthesize the legal and policy issues on climate change mitigation and adaptation.

Course Contents

Advanced concepts of Socio-economic benefits of Climate Services: Direct and indirect techniques; Normative method, Contingency valuation Method. Environmental and resource

economics: conceptual foundations and practical tools of analysis, including state-of-the-art quantitative methods; foundations of environmental and resource economics; economics of pollution control; economics of renewable and non-renewable resources; study of international environmental problems and agreements. Application of economic concepts and quantitative methods to the analysis, appraisal and valuation of a wide range of environmental problems and policies. Strategies of initiating social change in order to reduce the negative impacts of climate change. The role of government in public goods provision. Climate change policy and social change. International Laws and agreements; National Climate change policies; Trends in international agreements and protocols: Trends in international agreements. Applied economic analysis: The Stern Review and Bill Nordhaus. Applied analysis: sectors, rich and poor, now and later. Justice, Climate change and policy, analysis of future developments. Technological change: lessons, and policy; Status of international climate change negotiations; Analysis of the regulatory instruments that may be applied to achieve climate change policy goals; Evaluation of the effectiveness of voluntary agreements. Climate change policy and social change; Dynamics of international climate change negotiations; Voluntary agreements and social change in order to reduce the negative impacts of climate change.

SCC 803: Philosophy of Climate Change

Course Objectives:

To provide the student advanced knowledge of the Philosophical approach to the climate change issues

Learning Outcomes:

At the end of the course the student should be able to:

1. Contribute knowledgably towards the debate on climate change issues
2. Play a leading role in analysis and drafting of policies on climate change matters.

Course Contents

Philosophical dimensions of climate change. Philosophical approach to the climate change issues. Contribution of philosophy to the climate change debate. The ethical issues at stake in global-warming policy. Our obligations to future generations. The faces of climate change that trigger action and reaction. Ethics and justice in the utilitarianism of economic cost-benefit analyses approaches to the climate change. Significance in learning to live with nature. Climate change and virtue ethics for the best utilitarian outcome. The truth about climate projection models. The role of climate Change models in shaping policy. The robustness and accuracy of

the climate models . Rethinking the relationship between humanity and the natural environment; enquiry into the basic philosophical principles that inform modern society. Climate change and the price for civilization. Climate Change, Civil Progress, and Rational Evolution, Nature in the Active Voice. Transforming Global Politics, Transforming Worldviews to Cope with a Changing Climate, Learning to Cope with Climate Change, Education Against Climate Change. Global Environmental Justice, Global Climate Change, Adaptation and Abatement in a Context of Risk and Vulnerability Gender and Climate Change: An Environmental Justice Perspective. Liberal Responsibility; Mediated Responsibilities, Global Warming and the Scope of Ethics. Transforming Attitudes to Environmental Law in Light of Climate Change.

SCC 804: Advanced Research Methods and Techniques

Course objectives: Provide advanced knowledge, skills, and competencies in scientific research methodologies.

Learning Outcomes:

At the end of the course the student should be able to:

1. Design scientific research problems, hypotheses and objectives.
2. Formulate and write different types of scientific research proposals.
3. Collect, process, synthesize and interpret scientific research data.
4. Communicate scientific research findings orally and through writing.

Course Contents

The Philosophy of research, purpose of research, research and innovations. Characteristics of a good researcher. The role of research in national development. Research as an enterprise. The formulation of research proposals; Identifying research problem, proposal formats, donor customized research proposal format. Components of a research proposal; literature review, Hypothesis formulation, general and specific objectives. Data collection and research methodology: analytical, numerical, qualitative; Experimental design; Questionnaire design, modeling, and simulation. Tools of Data analysis. Types of research report; paper for referred journal, Conference and workshop paper, thesis. Presentation and communication of results; oral presentation. Journal Impact factor. Emerging areas of research in climate change; Climate change monitoring, attribution: scenario simulation, mitigation, adaptation in various sectors. Research Ethics; plagiarism.

SCC 805: Integrated Modeling and Assessment of Climate Change on Ecosystem and Health

Course Objectives:

Provide advanced Knowledge and skills in Integrated Modeling and Assessment of Climate change on Ecosystem and Biosystems

Learning Outcomes:

At the end of the course the student should be able to:

1. Use integrated models to asses the impact of climate change on ecosystem and health
2. Skillfully monitor environmental change
3. Identify appropriate adaptation strategies**.**

Course Contents

Building a habitable planet: Chemical and biological processes, The origin of the earth and life on earth, photosynthesis and carbon cycle, nitrogen cycle and oxygen cycle; phosphorous. Marine biology-Ecosystem approach to Climate Change. Challenges related to fresh water ecosystem, coastal ecosystem vulnerability assessment. Wildlife –human conflict, protection of migratory corridors. Reducing the vulnerability of pastoralist by improving rangeland management, developing resilient crop-livestock production systems through better soil and water management. Ecosystem-based Adaptation programme approach. Role of indigenous knowledge in climate change participatory approaches. Climate human comfort; Climate and tourism; Climatic indices, stress induced diseases; Comfort indices; Health advisory services; Climate change and Infectious diseases, Vector born disease and climate change; Impact of air pollution and UV radiation on human health.

SCC 806: Integrated Climate Modeling and Climate Projections

Course Objectives:

Provide advanced Knowledge and skills in Integrated Climate Modeling and Climate Projection.

Learning Outcomes:

At the end of the course the student should be able to:

1. Model the effect of external forcing on climate
2. Project the future climate under various scenarios
3. Model the effect of land use change

Course Contents

Greenhouse gases and their effects on the physical state of the atmosphere. Concepts of GHG stabilization. History of Climate modeling. Procedure of developing climate model; parameterization of physical processes and verification of climate models. Evaluation of climate change modeling. Modeling of external and internal forcing. Modeling the effects of CO_2. Future projections under various scenarios. The need for Regional models; Techniques of downscaling. Analysis and interpretation of GCMs and RCMs outputs. Use and application of climate change models. Modeling the effect of deforestation . Modeling the influence of variability and change on the population dynamics of animal and plant species. Implication of climate change on wildlife and tourism. Modeling Approaches for Projecting Impacts of Climate Change on Ecosystems and the Biodiversity, tropical diseases under various scenarios.

SCC 807: Environmental Monitoring and Observational Techniques

Course Objectives:

Provide advanced Knowledge and skills in use and application of modern environmental monitoring and observational techniques.

Learning Outcomes:

At the end of the course the student should be able to:

1. Use current statistical software to analyze climatic data
2. Utilize satellite data in assessing the impacts of climate change
3. Use GIS in monitoring the impacts of climate change
4. Apply spatial modeling to environmental monitoring

Course Contents

Geographic Information Systems (GIS): Art and science of GIS, Sources of Spatial Data, GIS Application software. GIS data Models: Levels of Spatial Data Model Abstraction, Types of GIS Data Models, Modeling Geographic Data in Practice. Spatial Databases: Database planning, Database Design, Structuring Geographic Data. Spatial Sampling: Sampling, Methods of Interpolation (Deterministic and Geostatistics), Interpolation Accuracy. Spatial Analysis: Analytic Capabilities of GIS; Exploration, Overlay, Neighbourhood and Connectivity. Spatial Modeling: Types of Models, Technology for Modeling, Accuracy and Validation of Models. Applications of spatial modeling to environmental monitoring. Earth observation data for use in Climate Change studies.

SCC 808: Climate Change Response Strategies

Course Objectives:

Provide advanced Knowledge and skills in climate change response strategies that should be put in place at national and global levels.

Learning Outcomes:

At the end of the course the student should be able to:

1. Attain good knowledge on the impacts of climate change on natural systems and on various socio-economic sectors.
2. Understand the factors that lead to increased vulnerability to climate change.
3. Understand the linkage between climate change and national development goals and be able to identify and assess appropriate adaptation and mitigation technologies.
4. Obtain knowledge on the national policies and measures including international cooperation to respond to climate change.

Course Contents

Climate Change: A global perspective. History of climate change as a global problem. Assessing the evidence and impacts of climate change; temperature trends and rainfall patterns. Impacts of climate change on: natural systems, economic sectors, physical and social infrastructure. Vulnerability assessment, and impacts monitoring. Linkage between climate change response strategies and development goals. Adaptation and mitigation interventions in the various socio-economic sectors. Nationally Appropriate Mitigation Actions (NAMAs). Communication, public education, awareness raising and capacity building. Research, Technology development, transfer, absorption and diffusion. Climate change governance; United Nations Framework Convention on Climate Change (UNFCCC), Climate Change Policy and Response Strategy-National Action Plan. Institutions governing climate change action plan and resource mobilization. Economic basis for emissions trading Market based green house gases stabilization mechanisms- Kyoto Protocol, Emissions Trading, Joint Implementation and the Clean Development Mechanism (CDM).

SCC 809: Climate Change and Energy Resources Technologies

Course Objectives:

Provide advanced knowledge and skills in climate change and energy resources technologies

Learning Outcomes:

At the end of the course the student should be able to:

1. Analyze the linkage between development and energy use
2. Evaluate the cost benefit of the green energy technology
3. Map the areas of high potential for wind and solar energy

Course Contents

Energy resource and development. Components of global energy system and CO_2 emissions; The principles of stabilization; Global energy resources; Understanding and scaling the technology options; The "technology-push" versus "demand-pull" debate: significance and evidence; Strategic deployment costs and subsequent benefits, including potential impact of rising CO_2 prices; Integrated perspectives: the innovation chain, innovation in the energy sector; A framework for narrowing the innovation gap; A classification of policies for narrowing the innovation gap; International agreements on strategic deployment and barrier removal. Climate change and energy; Energy resources and Global Warming; Renewable Energy Resources:; Wind Power Computations; Wind Energy Resource Assessment;; Environmental Impact of wind power plants; Micro-Hydro Power (MHP) Resources; Resource Assessment for MHP; Social and Environmental Aspects; Geothermal energy; Classes of Geothermal Energy Sources and Regions; Harnessing Geothermal Resources: Solar power: Nature of Solar and Atmospheric Radiation; Factors affecting solar radiation; Solar Energy Wave power; Wave energy and power; Devices for Extracting Power from the Waves; Tidal power; The cause of tides; Energy of Tides; Utilizing Electric Energy from Tidal Power Plants; Biomass and biofuels; Review of Anaerobic Digestion Technologies; Environmental Impacts of Biomass Energy.

SCC 810: Climate Change, Urbanization, Land Use and Development

Course Objectives:

Provide advanced Knowledge and skills in climate change, urbanization, land use and development.

Learning Outcomes:

At the end of the course the student should be able to:

1. Evaluate the interaction the interaction between climate change and land use change
2. Analyze the drivers of urbanization
3. Model the effects of urbanization on microclimate

Course Contents

Economic, social and environmental risks in changing climate; Land use; rates, causes, and consequences of land-use and land-cover change; Urbanization and Microclimatology:; Urban heat Island, Air quality status of urban areas; gaseous and particulate pollutants; Aerosols and radiation balance; Precipitation processes; Large industrial/human centres and climate; Climatology of building and urban planning; Comfort indices; Short and long term urban climate modification; the global carbon cycle and other biogeochemical cycles; climate and land use change impacts on water availability and hydrologic extremes; coastal response to climate and land use change; impacts of climate and land-use change on ecosystems; patterns and drivers of land use and land cover change; mapping and quantifying land use and land cover (LULC); Scenarios and Modeling of LULC; Land use planning and land protection tools; Economic development and Market-Based Incentives; climate change and development planning; economics and environmental management; Sustainable development and Climate Change nexus; Tools for analysis and assessment; land use and climate change mitigation; sustainable development and climate change policy; International policy processes and bilateral cooperation.

SCC 811: Climate change Agriculture and Food Systems

Course Objectives:
Provide advanced Knowledge and skills in climate change agriculture and food Systems.

Learning Outcomes:
At the end of the course the student should be able to:

1. Evaluate the effect of climate change on food production
2. Model the future food security under various scenarios
3. Provide critical analysis on the risk of adopting genetically modified crops as adaptation strategy to climate change

Course Contents
Climate Change in relation to plant growth and development: Effects on photosynthesis, transpiration and crop water use efficiency. Effects of climate change on soil conditions in relation to plant growth. CO_2 fertilization effect in relation to higher carbohydrate production and retention as biomass and seed yield. Impacts of higher day and night temperatures on growth and yields of some crop plants. Impacts of agriculture on climate change. The potential effects of climate change on food production and security. Climate Change in relation to Crop

growth and development models**.** Impacts of global climate change on food systems. Climate change, global agriculture and regional vulnerability. Climate Smart Agriculture approach to climate change, agriculture and food systems. *Value Chain* Approach to *Climate Change* Adaptation in *Agriculture.* Genetically modified crops and climate change. Assessment of current knowledge and critical gaps in climatic change and agricultural production.

SCC 812: Climate Change and Water Resources

Course Objectives:

This course aims at ensuring the student acquires analytical understanding of the major hydrological processes and their earth-atmosphere interaction in the context of climate change.

Learning Outcomes:

At the end of the course the student should be able to:

1. Explain observed and projected changes in climate that relates to water resources
2. Discuss the earth-atmosphere interactions of the main hydrological process including climate and non-climate drivers of freshwater availability
3. Demonstrate the consequences of future changes in water resources availability and demand due to climate change
4. Explain the principles of climate change mitigation that relates to water and implications on policy and sustainable development

Course Contents

Basics of the water cycle. Observed and projected changes in climate as they relate to water: precipitation (including extremes) and water vapour; snow and land ice; sea level; Evapotranspiration; soil moisture; runoff and river discharge; patterns of large-scale variability. Influences and feedbacks of hydrological changes on climate: Land surface effects; changes in ocean circulation; emissions and sinks affected by hydrological processes. Linking climate change and water resources (impacts and responses): observed climate change impacts; observed effects due to changes in the cryosphere; hydrology and water resources. Future changes in water availability and demand due to climate change: Climate and non-climate related drivers of freshwater systems. Impacts of climate change on freshwater in the future: availability, demand, stress, costs and socio-economic aspects. Regional aspects of climate change and water resources. Climate change mitigation measures and water. Implications for policy and sustainable development.

SCC 820: Ph.D Thesis

Course Objectives:

Provide practical skills in research and publication in areas related to climate change issues.

Learning Outcomes:

At the end of the course the student should be able to:

1. Be proficient in research proposal writing on climate change related subjects
2. Effectively review literature on climate change topics.
3. Carry out research that provide practical solutions to climate change related problems
4. Effectively disseminate research findings..

Course Contents

Scholarly exploration, critical analysis and development of research question or theory which is situated within a tradition of existing knowledge and research and which is then rigorously investigated to generate an original and meaningful theoretical or practical contribution to the science of climate change. This process adheres to the following guidelines: introduction to the study; background, statement of the problem, justification, objectives, research questions and hypotheses; theoretical and conceptual frameworks, limitations of the study, definition of terms; literature review; methodology: design of the investigation' tools and approaches, data collection; data types and sources including quality control; data analysis procedures; results and discussions: presentation of the findings, discussion of the findings; summary, conclusions and recommendations; references; appendices.

TEACHING STAFF

S/N	Name of Staff	Academic Rank	Gender	Department/Institute/School	College
1	Prof. Francis M. **Mutua**	Professor	Male	Meteorology	CBPS
2	Prof. David N. **Mungai**	Associate Professor	Male	Wangari Mathai Institute (WMI)	CAVS
3	Prof. John K. **Ng'ang'a**	Associate Professor	Male	Meteorology	CBPS
4	Prof. Nzioka J. **Muthama**	Associate Professor	Male	Meteorology	CBPS
5	Prof. Joseph M. **Ininda**	Associate Professor	Male	Meteorology	CBPS
6	Dr. Josiah Mwivandi **Kinama**	Senior Lecturer	Male	Plant Science & Crop Protection	CAVS
7	Dr. John M. **Githaiga**	Senior Lecturer	Male	School of Biological Sciences	CBPS
8	Dr.-Ing. Faith Njoki **Karanja**	Senior Lecturer	Female	Geospatial & Space Technology	CAE
10	Dr. Wilfred Nyambune **Nyangena**	Senior Lecturer	Male	School of Economics	CHSS
11	Dr. Gilbert O. **Ouma**	Senior Lecturer	Male	Meteorology	CBPS
12	Dr. Christopher **Oludhe**	Senior Lecturer	Male	Meteorology	CBPS
13	Dr. Fredrick K. **Karanja**	Senior Lecturer	Male	Meteorology	CBPS
14	Dr. Raphael E. **Okoola**	Senior Lecturer	Male	Meteorology	CBPS
15	Dr. Alfred O. **Opere**	Senior Lecturer	Male	Meteorology	CBPS
16	Dr. Franklin J. **Opijah**	Senior Lecturer	Male	Meteorology	CBPS
17	Dr. Joseph Nzau **Mutemi**	Lecturer	Male	Meteorology	CBPS
18	Dr. Wilson **Gitau**	Lecturer	Male	Meteorology	CBPS

FEES STRUCTURE: PhD in Climate Change Programme

Each course unit costs KShs. 50,000/= and the total cost of fees payable to the University is KShs. 593,500/=. The fee structure is as follows:

S/N	ITEM	DETAILS	Semester 1	Semester 2
			COST (KSHS)	**COST (KSHS)**
Year 1				
1	Tuition Fees	6 course unit @50,000 each	150,000	150,000
2	Examination fees	6 Examination fees @3,000 each	12,000	12,000
3	Registration	2,000 (per year)	2,000	----
4	Student ID	500 (per year)	500	----
5	Medical	5,000 (per year)	5,000	----
6	Library	3,000 (per year)	3,000	----
7	Activity	2,000 (per year)	2,000	----
8	Caution	5,000 (once and refundable)	5,000	----
9	Computer Fee	5,000 (per year)	5,000	----
Year 1 Total			**184,500**	**162,000**
Year 2 and 3				
10	Proposal and Thesis Supervision	50,000 (per year)	100,000	
11	Field Work	50,000 (per year)	100,000	
12	Thesis Examination Fees	12,000(once)	12,000	
13	Registration	2,000 (per year)	4,000	
14	Student ID	500 (per year)	1,000	
15	Medical	5,000 (per year)	10,000	
16	Library	3,000 (per year)	6,000	
17	Activity	2,000 (per year)	4,000	
18	Computer Fee	5,000 (per year)	10,000	
		Year 2 and 3 Total	**247,000**	
		Total	**593,500**	

Foreign students shall pay more by 25% of the total

Other charges (Ksh)	Year 1	Year 2	Year 3
Research	250,000	250,000	250,000
Book allowance	50,000	50,000	50,000
Thesis re-submission			

FACILITIES

I. Common lecture rooms

- Large Lecture Theatre (LLT)
- Small Lecture Theatre (SLT)
- Science Workshop (SWS)
- Room G39

II. Networked Computer Laboratories

School of Physical Science Computer Labs & G37 Computer Labs

Departmental Computer Laboratory

III. Environmental Urban Monitoring Station

- Synoptic Weather observatory – measurements of Rainfall, Evaporation, Temperatures, Relative Humidity (RH), cloud cover, Mean wind speed, Visibility
- Air pollution monitoring Equipment: (Carbon-monoxide analyzer and Ozone analyzer)

IV. Field station at Kibwezi

An Agro-Meteorological Observatory Measurements of Rainfall, Evaporation, Soil Temperatures at different depths, Air Temperatures, Relative Humidity, Wind speed and Direction, Cloud cover, visibility, Radiation measurements.

V. Climate Change models used in SPS

- PRECIS (Providing Regional Climates for Impacts Studies)
- MAGGICC SCENGEN: Model for the Assessment of Green house Gas induced Climate Change-A Regional Scenario generator
- WFR: The Weather Research and Forecasting Model
- COSMO: is a nonhydrostatic limited-area atmospheric prediction model. It has been designed for both operational numerical weather prediction (NWP) and various scientific applications on the meso-β and meso-γ scale.
- HYSPLIT MODEL; Hybrid Single-Particle Lagrangian Integrated Trajectory
- COART Model: Coupled Ocean and Atmosphere Radiative Transfer
- SYSTAT
- STATA
- SPSS

VI. Projectors

Two (2) Liquid Crystal Display (LCD) projectors

REFERENCE MATERIAL (LIBRARY RESOURCES)

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John Houghton, 2009: Global Warming, The Complete Briefing. *Fourth Edition, Cambridge University Press.* ISBN: 0521882567, 9780521882569, 438 pages *http://en.booksee.org/book/663665*

K. B. Z. Ogutu, F. D'Andrea, M. Ghil, C. Nyandwi, M. M. Manene, and J. N. Muthama Coupled Climate–Economy–Biosphere (CoCEB) model – Part 1: Abatement share and investment in low carbon technologies. Earth Syst. Dynam. Discuss., 6, 819-863, doi:10.5194/esdd-6-819 2015, 2015

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Leslie Lipper, Bernardete Neves, Andreas Wilkes, Timm Tennigkeit, Pierre Gerber, Ben Henderson, Giacomo Branca and Wendy Mann, 2009: Climate Change Mitigation Finance for Smallholder Agriculture: A guide book to harvesting soil carbon sequestration benefits. *Food and Agriculture Organization of the United Nations (FAO).* *http://www.fao.org/climatechange/29763-0daebeae838c70f713da780982f16e8d9.pdf*

Mark Pelling, 2010: Adaptation to Climate Change: From Resilience to Transformation. *Amazon Publishers; https://books.google.com*

Mark Pelling, Ben Wisner and Anna Kajumulo Tibaijuka, 2008: Disaster Risk Reduction: Cases from Urban Africa. *Amazon Publishers; https://books.google.com*

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EVIDENCE OF APPROVAL

1. Departmental meetings held on January 17, 2013, September 25, 2013 and February 18, 2014
2. School Academic Board meeting held on May 8, 2014
3. College Academic Board meeting held on November 13, 2014
4. BPS Board meeting held on May 14, 2015

LIST OF STAKEHOLDERS CONSULTED

The following stakeholders were sent copies of the draft curriculum with a request for comments and feedback:

1. ICCA : Institute of Climate Change Adaptation
2. ICPAC : IGAD Climate Prediction and Application Centre
3. KEWI : Kenya Water Institute
4. KFS : Kenya Forest Service
5. KMS : Kenya Meteorological Service
6. NCCS : National Climate Change Secretariat

7. CODL : Centre for Open and Distance Learning
8. RIVA VET : Riva Veterinary Services
9. UNEP : United Nations Environmental Program
10. Department of Geography and Environmental Sciences, UoN
11. Department of Sociology, UoN
12. Department of Geology, UoN
13. Department of Geospatial Engineering, UoN
14. School of Economics, UoN

Stakeholders' feedback reports

The following stakeholders were able to send their feedbacks and comments which were in cooperated in the final draft:

1. Kenya Forest Service
2. Ministry of Environment, Water & Natural Resources: Climate Change secretariat
3. Institute for Climate Change and Adaptation (ICCA)
4. UNEP
5. KMS
6. ICPAC
7. Dept of Geography and Environmental Studies
8. School of Economics