COURSE SYLLABUS

LAST REVIEW	Spring 2021
COURSE TITLE	Climate Studies and Laboratory
COURSE NUMBER	BIOL-0250
DIVISION	Math, Science, Business & Technology
DEPARTMENT	Physical Sciences
CIP CODE	24.0101
CREDIT HOURS	4
CONTACT HOURS/WEEK	Class: 3 Lab: 2
PREREQUISITES	None
COURSE PLACEMENT	None

COURSE DESCRIPTION
Climate Studies and Laboratory is an undergraduate climatology course. It is intended to provide students with a comprehensive study of the principles of climatology while providing pedagogically appropriate investigations and applications using web-delivered climate data.

General Education Learning Outcome
☐ Basic Skills for Communication
☐ Mathematics
☐ Humanities
☒ Natural and Physical Sciences
☐ Social and Behavioral Sciences

Institutional Learning Outcomes
☐ Communication
☒ Computation and Financial Literacy
☒ Critical Reasoning
☒ Technology and Information Literacy
☐ Community and Civic Responsibility
☐ Personal and Interpersonal Skills

TEXTBOOKS
http://kckccbookstore.com/

METHODS OF INSTRUCTION

A variety of instructional methods may be used depending on content area. These include but are not limited to: lecture, multimedia, cooperative/collaborative learning, labs and demonstrations, projects and presentations, speeches, debates, panels, conferencing, performances, and learning experiences outside the classroom. Methodology will be selected to best meet student needs.

COURSE OUTLINE

I. Climate Science for Today's World
   A. Climate versus Weather
   B. The Climatic Norm
   C. Historical Perspective
   D. Climate and Society
   E. Atmosphere
   F. Hydrosphere
   G. Cryosphere
   H. Geosphere
   I. Biosphere
   J. Subsystems Interactions: Biogeochemical Cycles
   K. The Climate Paradigm

II. Monitoring Earth's Climate System
   A. Spatial Scales of Climate
   B. Climate Variability and Climate Change
   C. Climatic Anomalies: Feedback Loops, Tipping Points
   D. Observing the Climate System: In Situ Measurement, Remote Sensing by Satellite, NASA's Earth Observing System
   E. International Cooperation in Understanding Earth's Climate System: Global Earth, Observation System of Systems (GEOSS), Intergovernmental Panel on Climate Change (IPCC)
   F. Modeling Earth's Climate System: Short-Term Climate Forecasting, Long-Term Climate Forecasting
   G. Lessons of the Climate Record

III. Planetary Energy Budget in Earth's Climate System
   A. Forms of Electromagnetic Radiation
   B. Radiation Laws
   C. Incoming Solar Radiation: Solar Altitude, Earth's Motions in Space and the Seasons, The Solar Constant
   D. The Atmosphere and Solar Radiation: Scattering and Reflection, Absorption
   E. Stratospheric Ozone Shield
   F. Earth's Surface and Solar Radiation
   G. Global Solar Radiation Budget
   H. Outgoing Infrared Radiation: Greenhouse Effect, Greenhouse Gases, The Callendar Effect
   I. Global Radiative Equilibrium and Climate Change

IV. Thermal Response of the Climate System
  A. Distinguishing Temperature and Heat: Temperature Scales and Heat Units, Measuring Air Temperature
  B. Heat Transfer Processes: Radiation, Conduction and Convection, Phase Changes of Water
  C. Thermal Response and Specific Heat: Thermal Inertia, Maritime and Continental Climates
  D. Heat Imbalance: Atmosphere versus Earth's Surface, Latent Heating, Sensible Heating
  E. Heat Imbalance in Tropics versus Middle and High Latitudes: Heat Transport by Air Mass Exchange, Heat Transport by Storms, Heat Transport by Ocean Circulation
  F. Controls of Air Temperature: Local Radiation Budget, Cold and Warm Air Advection, Anthropogenic Influence

V. Water in Earth's Climate System
  A. Global Water Cycle: Transfer Processes, Global Water Budget
  B. Water Vapor in the Atmosphere: Vapor Pressure, Saturated Air, Relative Humidity, Dewpoint, Precipitable Water
  C. Monitoring Water Vapor
  D. How Air Becomes Saturated: Atmospheric Stability, Lifting Processes
  E. Clouds: Cloud Classification, Fog
  F. Precipitation: Warm-Cloud Precipitation, Cold-Cloud Precipitation, Forms of Precipitation
  G. Measuring Precipitation: Rain and Snow Gauges, Remote Sensing of Precipitation

VI. Global Atmospheric Circulation
  A. Wind Forces: Pressure Gradient Force, Centripetal Force, Coriolis Effect, Friction, Gravity, Summary
  B. Wind Joining Forces: Geostrophic Wind, Gradient Wind, Highs, and Lows, Surface Winds in Highs and Lows
  C. Continuity of Wind
  D. Wind Measurement
  E. Scales of Atmospheric Circulation
  F. Planetary-Scale Circulation: Boundary Conditions, Pressure Systems and Wind Belts, Winds Aloft, Trade Wind Inversion
  G. Seasonal Shifts and Climates
  H. Westerlies of Middle Latitudes: Zonal and Meridional Flow Patterns, Blocking Systems and Weather Extremes
  I. Wind-Driven Ocean Gyres

VII. Atmospheric Circulation and Regional Climates
  A. Air Masses: North American Types and Source Regions, Air Mass Modification
  B. Fronts: Stationary Front, Warm Front, Cold Front, Occluded Front

C. Extratropical Cyclones: Upper-Air Support, Life Cycle, Cyclone Weather, Preferred Regions of Cyclogenesis, Principal Cyclone Tracks, Cold Side/Warm Side, Cold- and Warm-Core Systems
D. Anticyclones: Arctic and Polar Highs, Warm Highs, Anticyclone Weather
E. Monsoon Climates: Asian and African Monsoon, Monsoon of the American Southwest, Southwest Drying Trend
F. Local and Regional Circulation Systems: Sea (Lake) Breeze and Land Breeze, Mountain Breeze and Valley Breeze, Chinook Wind, Katabatic Wind, Desert Winds, Lake-Effect Snow

VIII. Climate and Air/Sea Interactions
A. Air/Sea Interactions
B. Mean State of the Ocean Circulation: Ekman Transport, Geostrophic Flow and Ocean Gyres, Upwelling and Downwelling, Thermohaline Circulation
C. El Niño, La Niña, and the Southern Oscillation: Historical Perspective, Neutral Conditions in the Tropical Pacific, Warm Phase, Cold Phase, Frequency, Historical Episodes, Predicting and Monitoring ENSO
D. North Atlantic Oscillation
E. Arctic Oscillation
F. Pacific Decadal Oscillation

IX. The Climate Record: Paleoclimates
A. Reconstructing Past Climates: Why and How?
B. Proxy Climate Data Sources, Historical Documents, Tree Growth Rings, Pollen Profiles, Deep-Sea Sediment Cores, Speleothems, Corals, Glacial Ice Cores, Stratigraphy and Geomorphology, Varves
C. Climates of Geologic Time
D. Climates of the Pleistocene Ice Age: Historical Perspective, Glaciers, Climate and Glaciers, Glaciers and Landscapes, Chronology and Temperature Trends
E. Climates of the Holocene
F. Climates of the Recent Millennium: Medieval Warm Period, Little Ice Age

X. Instrument-based Climate Record and Climatology of Severe Weather
A. Global Climate Patterns: Temperature, Precipitation, Climate Classification
B. Trends in Mean Annual Temperature: Integrity of Instrument Data, Global Warming
C. Changes in the Water Cycle
D. Lessons of the Climate Record
E. Climatology of Severe Weather
F. Thunderstorms: Classification of Thunderstorms, Where and When, Severe Thunderstorms, Thunderstorm Hazards
G. Tornadoes: Tornado Characteristics, Tornado Hazards, Where and When
H. Tropical Storms and Hurricanes: Hurricane Hazards, Where and When, Hurricane Life Cycle

XI. Natural Causes of Climate Change
A. Global Radiative Equilibrium and Climate Change

  B. Solar Variability and Climate Change: Faint Young Star Paradox, Sunspots, Maunder Minimum and the Little Ice Age
  C. Earth's Orbit and Climate Change: Milankovitch Cycles, Evidence from Deep-Sea Sediment Cores
  D. Plate Tectonics and Climate Change
  E. Volcanoes and Climate Change
  F. Atmospheric Composition and Climate Change
  G. Earth's Surface Properties and Climate Change: Snow and Ice Cover, Shrinkage of Arctic Sea-Ice Cover, Sea-Surface Temperature Pattern

XII. Anthropogenic Climate Change and the Future
  A. Human Activity and Climate Change: Trends in Greenhouse Gases, Aerosols, Changes in Land Use and Land Cover
  B. Anthropogenic versus Natural Forcing of Climate
  C. The Climate Future: Global Climate Models, Search for Cycles and Analogs, Enhanced Greenhouse Effect and Global Warming
  D. Potential Impacts of Global Climate Change: Rising Sea Level, Shrinking Glaciers, Arctic Environment, Tropical Cyclones, Marine Life, Global Water Cycle, Food Security
  E. Ocean Acidification

XIII. Climate Classification
  A. Methods of Climate Classification
  B. Köppen Climate Classification: Tropical Humid Climates, Dry Climates, Subtropical Climates, Snow Forest Climates, Polar Climates, Highland Climates
  C. Climate Change and Ecosystem Response
  D. Other Climate Classification Systems: Thornthwaite, Bergeron, Holdridge Life Zones

XIV. Responding to Climate Change
  A. Managing Anthropogenic Climate Change
  B. Climate Mitigation: Carbon Trading and Taxation, Alternative Energy Sources, Carbon Capture and Storage, Improving Transportation Sector Efficiency
  C. Climate Adaptation
  D. Geoengineering the Climate System: Ecosystem Sequestration, Sulfurous Haze, Brighter Ocean Clouds, Ocean Iron Fertilization, Potential of Geoengineering
  E. Climate-Conscious Architecture: Indoor Comfort, Heating and Cooling Degree Days

XV. Climate Change and Public Policy
  A. Policy Lessons from Stratospheric Ozone Depletion
  B. Global Climate Change and International Response: UN Framework Convention on Climate Change, Kyoto Protocol, Copenhagen Climate Change Conference
  C. Climate Change Policy: Precautionary Principle, Climate and Sustainability

D. Climate Policy Making at the National Level: Political Response, Incremental Decision Making
E. The Economic Perspective of Climate Change: Free Markets, Government Regulation, Analytic Tools
F. National Climate Service

COURSE LEARNING OUTCOMES AND COMPETENCIES

Upon successful completion of this course, the student will:

A. The student will be able to distinguish between weather and climate.
   1. The student will be able to define weather and climate.
   2. The student will be able to describe the contributions of the atmosphere, hydrosphere, cryosphere, geosphere, and biosphere to the climate system.

B. The student will be able to explain how climate variability differs from climate change.
   3. The student will be able to describe variations in climate.
   4. The student will be able to describe examples or elements of climate change.
   5. The student will be able to discuss the role of various measuring systems in making both short- and long-term climate forecasts.

C. The student will be able to describe the interactions that take place as solar radiation travels through the atmosphere.
   6. The student will be able to describe the greenhouse effect and identify the principal greenhouse gases.
   7. The student will be able to distinguish between scattering and absorption of solar radiation.
   8. The student will be able to explain the role of greenhouse gases in the Callender effect.
   9. The student will be able to explain the role of feedback loops in determining whether or not the earth's climate system reaches a tipping point.

D. The student will be able to explain how heat is transported via conduction and convection.
   10 The student will be able to distinguish between temperature and heat.
   11. The student will be able to describe the Earth's responses to heat imbalance.
   12. The student will be able to compare and contrast the heat transfer processes of radiation, conduction, convection, and phase changes of water.
   13. The student will be able to describe and distinguish cold and warm air advection.

E. The student will be able to describe the various water transfer processes operating between Earth's surface and atmosphere.
   14. The student will be able to describe how the saturation vapor pressure varies with air temperature.

15. The student will be able to compare and contrast the significance of hydroscopic nuclei in cloud formation.
16. The student will be able to compare and contrast the prevailing climate on the leeward versus windward slopes of a coastal mountain range.

F. The student will be able to identify the forces that initiate and govern the circulation of air (the wind).
    17. The student will be able to describe the Coriolis deflections in the Northern and Southern Hemispheres.
    18. The student will be able to compare and contrast geostrophic, gradient and surface winds.
    19. The student will be able to describe the individual forces (pressure gradient, centripetal, Coriolis, friction, and gravity) that initiate and shape the wind.
    20. The student will be able to describe the prevailing atmospheric circulation (semi-permanent pressure systems, wind belts, and the intertropical convergence zone (ITCZ)) on the planetary scale.

G. The student will be able to describe how and why air masses modify as they travel away from their source regions.
    21. The student will be able to compare and contrast a Mediterranean climate from a monsoon climate.
    22. The student will be able to explain what controls the temperature and humidity of an air mass.
    23. The student will be able to summarize the circulation systems that constitute synoptic-scale climatology.

I. The student will be able to describe the flux of heat energy and climate-sensitive materials that flow between ocean and atmosphere.
    24. The student will be able to compare and contrast El Niño, La Niña, and the Southern Oscillation.
    25. The student will be able to describe Ekman transport, its influence on upwelling and downwelling in coastal areas and its significance for ocean gyres.
    26. The student will be able to describe how El Niño and La Niña have a ripple effect on the weather and climate of middle latitudes around the globe.

J. The student will be able to list several biotic and abiotic proxy climate data sources.
    27. The student will be able to summarize the principal reasons for describing the Paleozoic Era climate in generalized terms.
    28. The student will be able to distinguish between glacial and interglacial climates in terms of glacial mass balance.
    29. The student will be able to discuss how plate tectonics can complicate climate reconstruction over periods spanning hundreds of millions of years.

K. The student will be able to list the various factors that contribute to spatial and seasonal variations in mean precipitation.
    30. The student will be able to discuss the climatology of severe weather such as thunderstorms, tornados, and hurricanes.
    31. The student will be able to identify several factors that may influence the integrity of the long-term instrument-based climate record.

L. The student will be able to describe natural causes of climate change.
    32. The student will be able to describe the effects of the three Milankovitch cycles on the distribution of incoming solar radiation by latitude and season.
    33. The student will be able to describe the role of sulfurous aerosols in climate change induced by a volcanic eruption.
    34. The student will be able to explain the effects of solar variability, the Earth's orbit, plate tectonics, atmospheric composition, the Earth's surface properties and global radiative equilibrium on climate change.

M. The student will be able to identify the principal reasons for the rising trend in CO_2 since the Industrial Revolution.
    35. The student will be able to identify the mechanism primarily responsible for a net positive radiative forcing in Earth's climate system.
    36. The student will be able to explain how the ocean influences the amount of CO_2 in the atmosphere.
    37. The student will be able to describe potential impacts of global climate change.

N. The student will be able to explain the diversity of climate types on Earth.
    38. The student will be able to compare and contrast the Köppen, Thornthwaite, Bergeron and Holdridge Life Zone climate classification systems.
    39. The student will be able to distinguish between a generic and an empirical climate classification.

O. The student will be able to discuss various responses to climate change.
    40. The student will be able to compare and contrast climate mitigation and geoengineering responses to climate change.
    41. The student will be able to explain how the time scales of climate change mitigation differ from that of climate change adaptation.
    42. The student will be able to explain how cap-and-trade works to reduce carbon dioxide emissions to the atmosphere.

P. The student will be able to summarize the advantage of a holistic approach to solving the problem of anthropogenic climate change.
    43. The student will be able to describe two major differences between protecting the ozone shield and curbing anthropogenic climate change.
    44. The student will be able to explain what is meant by incremental decision making.

ASSESSMENT OF COURSE LEARNING OUTCOMES AND COMPETENCIES
Student progress is evaluated through both formative and summative assessment methods. Specific details may be found in the instructor's course information document.

COLLEGE POLICIES AND PROCEDURES
Student Handbook
https://www.kckcc.edu/files/docs/student-resources/student-handbook-and-code-of-conduct.pdf

College Catalog
https://www.kckcc.edu/academics/catalog/index.html

College Policies and Statements
https://www.kckcc.edu/about/policies-statements/index.html

Accessibility and Accommodations
https://www.kckcc.edu/academics/resources/student-accessibility-support-services/index.html.