**MET 2101 Atmospheric Dynamics I (3CU)**

**Description**

This course covers the basics of atmospheric dynamics including conservation laws, development of the equations of motion, thermal wind, circulation and, vortices, and geostrophic motions.

**Objectives**

The course will help the students to achieve the following objectives

* Derive the equations of the relevant atmospheric forces
* Describe the momentum equation and its applications
* Describe the continuity equation and its applications
* Understand the vortices equation and its relevancy to atmospheric stability

**Learning outcomes**

By the end of the course students should be able to:

* Explain and describe the fundamental forces that act upon the atmosphere,
* Apply Newton’s second law of motion to the atmosphere to derive the momentum equations in both vector and scalar form,
* Explain how rotation of the Earth modifies the equations of motion and introduce Carioles force and centrifugal force,
* Derive the mass continuity equation and explain its meaning and use,
* Apply scale analysis to the governing equations and explain under what conditions the hydrostatic and geostrophic approximation are valid
* Derive thermal wind equation and explain how the vertical shear of the geostrophic wind relates to the horizontal temperature gradient,
* Derive circulation theorem and explain its significance to atmospheric motion,
* Derive vortices equation, and explain the significance of this equation for atmospheric motion,
* Define potential vortices and describe its application to atmospheric motion.

**Intellectual, Practical and transferable skills**

* Problem solving
* Analytical
* communication

**Teaching and learning patterns**

The mode of learning involves direct contact with students in form of lectures, Tutorials and assignments

**Indicative content**

* Basic forces: pressure gradient, viscosity (frictional) gravitational, Carioles and centrifugal forces.
* Equation of motion, advection, equation of motion in different coordinate systems.
* Scale analysis: geostrophic wind, Rossby number, hydrostatic approximation, continuity equation and pressure tendency equation, gradient motion, thermal wind equation and baroclinicity., cyclotropic motion and inertial motion.
* Circulation, vortices and divergence, conservation of vortices, and potential vortices.
* Primitive equations: pressure as coordinate system, hydrostatic balance, and thermodynamic energy equation.
* Charney’s scale analysis of divergence and vortices equations.
* Linear and non-linear balance equations, the quasi geostrophic balance equation

**Assessment Method**

The assessment method is structured to include course work, and final examination. Course work consists of assignments, reports and tests and accounts for 30% of the final grade. The final examination will account for 70% of the final grading

**Core Reference materials**

* **James R. Holton** (2004): An Introduction to Dynamic Meteorology, 4th Edition, *Academic press.*
* **James R. Holton** (1992): An Introduction to Dynamic Meteorology, 3rd Edition, *Academic press.*
* **George J. Haltiner and Frank L. Martin** (1957): Dynamical and Physical Meteorology, *New York, McGraw-Hill*