# THE FEDERAL UNIVERSITY OF TECHNOLOGY, AKURE

## *Department of Meteorology*

# MET 510 – Cloud Physics

## COURSE PARTICULARS

**Course Code:** MET 510
**Course Title:** Cloud Physics
**No. of Units:** 2
**Course Duration:** Two hours of theory, twice per week for 15 weeks.
**Status:** Compulsory
**Course Email Address:** met510@gmail.com
**Course Webpage:** http://www.met.futa.edu.ng/courseschedule.php?coursecode=MET%51001
**Prerequisite:** NIL

## COURSE INSTRUCTORS

**Dr A. A. Balogun**
*SEMS Building,*
*Dept. of Meteorology,*
*Federal University of Technology, Akure, Nigeria.*
***Phone:*** +2347067692875
***Email:*** aabalogun@futa.edu.ng

**Mr. E. A. Adefisan**
*Academic Building,*
*Dept. of Meteorology,*
*Federal University of Technology, Akure, Nigeria.*
***Phone:*** +2348060228778
***Email:*** eaadefisan@futa.edu.ng

and

**Mr. R. A. Balogun**
*SEMS Building,*
*Dept. of Meteorology,*
*Federal University of Technology, Akure, Nigeria.*
***Phone:*** +2348034474868
***Email:*** rabalogun@futa.edu.ng

## COURSE DESCRIPTION

Clouds are a vital link in the global climate and water cycle and an integral part of weather forecasting and analysis. A cloud is defined as a "visible aggregate of minute particles of water or ice, or both, in the free air". Cloud Physics consists of two branches: cloud microphysics and

cloud dynamics. The emphasis on cloud physics (MET 510) is on cloud microphysics, the study of the formation and growth of the "minute particles" making up the "visible aggregates". Emphasis, on the course, will be on the basic microphysical processes that are involved in the formation, growth, shrinkage, breakup, and fallout of cloud and precipitation particles. Furthermore, the microphysics of warm clouds (tropical clouds, where the temperature is everywhere above $0^0$C) and cold clouds (in which the temperature drops below $0^0$C and both ice and liquid particles may exist) covers the majority of the course. Formation, growth and decay of thunderstorms are also an essential part of the course.

## COURSE OBJECTIVES

The objectives of this course are to:

- impart on the students, as a necessary prerequisite, the knowledge needed for future work on tropical weather systems,
- prepare students on the task of cloud systems and storm structure analysis; and.

## COURSE LEARNING OUTCOMES / COMPETENCIES

Upon successful completion of this course, the student will be able to:
*(Knowledge based)*

- distinguish between cloud microphysics and cloud dynamics;
- describe some of the basic microphysical processes that are involved in cloud systems;
- distinguished between warm and cold clouds;
- understand the formation, growth and decay of thunderstorm systems;

*(Skills)*

- understand the principle of operation of weather radars; and
- identify thunderstorm systems.

## GRADING SYSTEM FOR THE COURSE

This course will be graded as follows:

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|---|---|
| Class Attendance | 10% |
| Assignments | 15% |
| Test(s) | 15% |
| Final Examination | 60% |
| **TOTAL** | **100%** |

# GENERAL INSTRUCTIONS

***Attendance:*** It is expected that every student must be in class at most five (5) minutes before the lecture commence and also participate in all practical exercises. Attendance records will be kept and used to determine each person's qualification to sit for the final examination. In case of illness or other unavoidable cause of absence, the student must communicate as soon as possible with any of the instructors, indicating the reason for the absence.

***Academic Integrity:*** Violations of academic integrity, including dishonesty in assignments, examinations, or other academic performances are prohibited. You are not allowed to make copies of another person's work and submit it as your own; that is plagiarism. All cases of academic dishonesty will be reported to the University Management for appropriate sanctions in accordance with the guidelines for handling students' misconduct as spelt out in the Students' Handbook.

***Assignments and Group Work:*** Students are expected to submit assignments as scheduled. Failure to submit an assignment as at when due will earn you zero for that assignment. Only under extenuating circumstances, for which a student has notified any of the instructors in advance, will late submission of assignments be permitted.

***Code of Conduct in Lecture Rooms and Observatories:*** Students should turn off their cell phones during lectures. Students are prohibited from engaging in other activities (such as texting, watching videos, *etc*.) during lectures. Food and drinks are not permitted in the observatories.

# READING LIST

[2] Houze, R. A., Jr. (1993), Cloud Dynamics, 573 pp., Academic, San Diego, Calif.

[2] Rogers, R. R., and M. K. Yau, 1989: A Short Course in Cloud Physics, 3rd ed. Pergamon Press, Oxford, 293pp.

***Legend***
1- Available in the University Library
2- Available in Departmental/School Libraries

## COURSE OUTLINE

| Week | Topic | Remarks |
|---|---|---|
| 1 | Introduction and Course Overview | This first class will be more of definition of simple but important terms related to the course (e.g., forms of water: water vapour, cloud liquid water, precipitation liquid water, cloud ice, and precipitation ice). |
| 2 & 3 | Physics of evaporation and condensation. | This will cover processes associated with evaporation and condensation. |
| 4 | Supersaturation | Students are expected to be able to differentiate between the curvature and solute effects. |
| 5 & 6 | Atmospheric aerosol concentration, size spectra, sources, and sinks.<br>Cloud Condensation Nuclei | Students should be able to differentiate between primary and secondary sources of aerosols, identify size spectra, sources and sinks of aerosols.<br>Students are also expected to know the difference between hygroscopic and hydrophobic nuclei. |
| 7 & 8 | Cloud Microphysical Process: Droplet Growth by Diffussion | Simple diffusion growth equation and their applications.<br>**Emphasis:** Diffusional growth is certainly the way that small droplets initially grow into larger cloud droplets.<br>**Emphasis:** Clouds are observed to form and produce rain on much shorter time scales (30 minutes) than can be achieved by diffusional growth alone. Therefore, diffusional growth can't be how precipitation forms. |
| | | MID-SEMESTER TEST |
| 9 & 10 | Cloud Microphysical Process: Droplet Growth by Collision-Coalescence. | Terminal Velocities.<br>The collision-coalescence process is often called the *warm-rain process*, since it is the only way to explain precipitation formation in clouds that remain above freezing. However, it can also occur in cold clouds. |

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|---|---|---|
| 11 & 12 | Precipitation and Radar. | Types and mechanisms of precipitation formation.<br>General Principle of radar, radar equation and use of reflectivity to estimate rainfall rate. |
| 13 & 14 | Thunderstorms Systems | Brief description of the Cumulonimbus (Cb) cloud.<br>Formation, growth and decay of thunderstorms.<br>Lightning Characteristics inside cloud. |
| 15 | REVISION | Review and revision, followed by assessment. |