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**Department of Environmental Sciences**

**College of Sciences**

**University of Salahaddin**

**Subject: Meteorology Theory**

**Course Book – (2nd Year)**

**Lecturer's name Dr. MOHAMMED AZEEZ OTHMAN**

**Academic Year: 2022/2023**

**Course Book**

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| **1. Course name** | **Meteorology** | |
| **2. Lecturer in charge** | **MOHAMMED AZEEZ OTHMAN** | |
| **3. Department/ College** | **Environmental Sciences - Sciences** | |
| **4. Contact** | **e-mail: mohammed.othman@su.edu.krd**  **Tel: (optional) 009647504611803** | |
| **5. Time (in hours) per week** | **For example Theory: 2 Supervision** | |
| **6. Office hours** | **Every day before and after the lecture except off day** | |
| **7. Course code** |  | |
| **8. Teacher's academic profile** | * **I graduate from Salahaddin University/ College of**   **Science/ Biology department in 2003 (Ranked 8 the in**  **College).**   * **In 2004 I worked as assistant biology for 2**   **Years and assisted in practical ecology lab.,**  **microbiology lab., practical soil lab., practical sewage**  **Microbiology lab. and practical plant physiology lab.**   * **In 2008 I completed my M.Sc. degree and in same**   **year I started as Assistant Lecturer Teaching Practical Limnology and pollution, and theory waste management in the same college.**   * **For 3 years (2009-2011) I worked as a Member of the**   **Examination Committee for College of Science.**   * **I participated in Teaching Methods Course in 2009in the same university.** * **In 2018 I completed my PhD. degree and in same year**   **I started Teaching theory population and Ecology.** | |
| **9. Keywords** | **sunlight, wind formation, diabetic rate pressure and humidity.** | |
| **10. Course overview:**  **The course will cover principle information about Meteorology, and understanding of atmosphere requires knowledge not only of the earth atmosphere themselves but also of those external influences which directly or indirectly affect them. A suitable environment is necessary for any organism, since life depends upon the continuance of a proper exchange of essential substances and energies between the organism and its surroundings. And the study of the weather or atmospheric factors such as temperature, pressure, wind, precipitation and sun energy and others. The course will give students a better understanding of the Environment that surrounded us** | | |
| **11. Course objective:**  **The course will cover principle information about Climate, temperature, pressure, rainfall as so on and how use some sources of energy as cleaner and safer for organisms especially human on the earth. The course will give students a better understanding of the different type of inland water, and teaching the student how protect the Environment from of pollution** | | |
| **12. Student's obligation**  **When I ask the student for preparing in class, and in the exam, preparing and writing a report and discusses in class, this stimulate the students to become more active and able to learn more things about environment science.** | | |
| **13. Forms of teaching**  **Different forms of teaching will be used to reach the objectives of the course: power point presentations for the head titles and definitions and summary of conclusions, classification of metrology phenomenon and any other illustrations, besides worksheet will be designed to let the chance for practicing on several aspects of the course in the classroom, furthermore students will be asked to prepare research papers on selective topics and summarise articles contents published in English into either Kurdish or Arabic language, those articles need to be from printed media or internet articles. There will be classroom discussions and the lecture will give enough background to translate, solve, analyse, and evaluate problems sets, and different issues discussed throughout the course.**  **To get the best of the course, it is suggested that you attend classes as much as possible, read the required lectures, teacher’s notes regularly as all of them are foundations for the course. Lecture’s notes are for supporting and not for submitting the reading material including the handouts.try as much as possible to participate in classroom discussions, preparing the assignments given n the course.** | | |
| **14. Assessment scheme**  **Your final grade will be derived as follows:**  **Quizzes: About 10 quizzes will be given throughout the semester. They will be given at the beginning of the class period and last 10 minutes.10% of your grade.**  **Exams: There will be two closed book exams given throughout the semester. Each test will be scheduled for 90 minutes.30% of your grade.**  **Final Exam: The Final Exam is Comprehensive in all course outlines.60% of your grade‌**  **Mean of two examinations: 40%**  **Final examination: 60%**  **Final Exam: The Final Exam is Comprehensive in all course outlines.60% of your grade‌**  **Mean of two examinations: 40%**  **Final examination: 60%** | | |
| **15. Student learning outcome**  **Meteorology and Clean Energy is one of the most important lecture in Environmental Sciences Department because the student in this course learn the student many things about Meteorology and Clean Energy that around us and can the student to water management , how pollution control , guideline of safe and health Environment and increase the number of people who not full-time water can understand and apply its general concepts to a broad range of related disciplines all these things can students apply in our daily life for services the community** | | |
| **16. Course Reading List and References‌:**  **Required book:**  **1- The Atmosphere, F.K. Lutgens and E.J. Tarbuck, Ninth (2003) or Tenth Edition (2007) The Weather Cycler for interpreting and forecasting your weather. Optional activity kit. All other course materials are available on the Internet.**  **2- Meteorological Measurement Systems, by Fred V. Brock and Scott J. Richardson, Oxford University Press, 2001.**  **3-Instructor’s Handbook on Meteorological Instrumentation, by Fred V. Brock (Editor) and Carol E. Nicholaidas (Assistant Editor), NCAR/TN-237+IA, 1984.**  **4-Federal Meteorological Handbook No. 1 (FMH-1), by OFCM, 1995.**  **5- National Aeronautics and Space Administration, "The Importance of Understanding Clouds," NASA Facts, FS-2005-0-073-GSFC, http://www.nasa.gov/pdf/135641main\_clouds\_trifold21.pdf.**  **6-Ather, G.D. ( 2005). Essential Meteorology. 3rd Edition. Doubleday and Co., Garden City, NY.**  **7. Prof. R N Singh, Professor, School of Energy and Environmental Studies, Devi Ahilya Vishwavidyalaya, Indore**  **8. Prof. J S Saini, Professor Emeritus, Department of Mechanical and Industrial Engineering, IIT Roorkee**  **9. Dr. R.L. Sawhney, Former Professor, TERI Unievrsity, Delhi; School of Energy and Environmental Studies, Devi Ahilya Vishwavidyalaya, Indore**  **The core materials of the course consists of the above book, articles from media and internet, and lecture’s notes, make sure you read all the materials and prepare well before going for the examinations.**  **Students are encouraged to search for any other materials that may help improve their English language ability in reading, writing, listening and speaking plant communities' texts.** | | |
| **17. The Topics:** | | **Lecturer's name** |
| **Week 1:**  **Introduction to Meterology**  **.Climate**  **. Weather**  **. Motivation to study Meteorology**  **Week 2:**  **Structure of Earth’s atmosphere**  **. Vertical Structure of the Atmosphere (Air pressure and air density)**  **Week 3 & 4:**  **Earth's Energy Budget**  **. Feedbacks in the Atmosphere**  **. Energy: Warming the earth and Atmosphere**  **Week 5:**  **Radiation and Temperature**  **. Measuring Temperature**  **Week 6 &7:**  **Vertical motion in the atmosphere**  **. Measurement of air pressure**  **Week 8**  **The water cycle/moisture Clouds and fog**  **Week 9**  **Stability Precipitation**  **Week 10:**  **Atmospheric pressure Atmospheric forces**  **Week 11:**  **Local Winds Global circulation**  **Week 12:**  **Wind Power El Niño‐Southern Oscillation**  **Week 13 and 14:**  **Air masses , Weather Forecasting Thunderstorms**  **Week 15 and 16:**  **Weather stations** | | **Janan Jabbar Toma**  **ex:(2 hrs)** |
| **18. Practical Topics (If there is any)** | |  |
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| **19. Examinations:**  **Examples of Examinations**  **First Examination**  **Q1:- Explain about Vertical Structure of the Atmosphere (AIR PRESSURE AND AIR DENSITY)**  **Q2:- Write about the following terms?**  **LAYERS OF THE ATMOSPHERE**  **Q3:- define the following terms? -SCATTERED AND REFLECTED LIGHT**  **Q4:- What is Precipitation Processes**  **Q5:- How Measuring Air Pressure?**  Typical answers  **Q1:- Explain about Vertical Structure of the Atmosphere (AIR PRESSURE AND AIR DENSITY)**  **Sol)** Air molecules (as well as everything else) are held near the earth by gravity. The air near the surface is compressed, air density normally decreases rapidly at first, then more slowly as we move farther away from the surface. The amount of force exerted over an area of surface is called atmospheric pressure or, simply, Air pressure. Atmospheric pressure always decreases with increasing height. Unit for air pressure found on surface weather maps is the millibar (mb), although the hectopascal\* (hPa) is gradually replacing the millibar as the preferred unit of pressure on surface maps. Another unit of pressure is inches of mercury (Hg), With a sealevel pressure near 1000 mb At an elevation approaching the summit of Mount Everest (about 9 km), the air pressure would be about 300 mb. The summit is above nearly 70 percent of all the molecules in the atmosphere.    **Q2:- Write about the following terms?**  **LAYERS OF THE ATMOSPHERE**  **Sol)** LAYERS OF THE ATMOSPHERE Look closely at Fig. 1.7 and notice that air temperature normally decreases from the earth’s surface up to an altitude of about 11 km. This decrease in air temperature with increasing height is due primarily to the fact that sunlight warms the earth’s surface, and the surface, in turn, warms the air above it. The rate at which the air temperature decreases with height is called the temperature Lapse rate. lapse rate in this region of the lower atmosphere is about 6.5 degrees Celsius (°C) for every 1000 meters (m). The region of the atmosphere from the surface up to about 11 km contains all of the weather we are familiar with on earth. This region of circulating air extending upward from the earth’s surface to where the air stops becoming colder with height is called the Troposphere just above 11 km the air temperature normally stops decreasing with height. Here, the lapse rate is zero. This region, where the air temperature remains constant with height, is referred to as an isothermal (equal temperature) zone. The bottom of this zone marks the top of the troposphere and the beginning of another layer, the Stratosphere. The boundary separating the troposphere from the stratosphere is called the Tropopause. in the stratosphere at an altitude near 20 km (12 mi), the air temperature begins to increase with height, producing a temperature inversion. The inversion region, along with the lower isothermal layer, tends to keep the vertical currents of the troposphere from spreading into the stratosphere.      **Q3:- define the following terms? -SCATTERED AND REFLECTED LIGHT**  **Sol)** When solar radiation enters the atmosphere, a number of interactions take place. For example, some of the energy is absorbed by gases, such as ozone, in the upper atmosphere. Moreover, when sunlight strikes very small objects, such as air molecules and dust particles, the light itself is deflected in all directions—forward, sideways, and backwards. 4/13 The distribution of light in this manner is called scattering. (Scattered light is also called diffuse light.) Because air molecules are much smaller than the wavelengths of visible light, they are more effective scatterers of the shorter (blue) wavelengths than the longer (red) wavelengths. Hence, when we look away from the direct beam of sunlight, blue light strikes our eyes from all directions, turning the daytime sky blue. At midday, all the wavelengths of visible light from the sun strike our eyes, and the sun is perceived as white. At sunrise and sunset, when the white beam of sunlight must pass through a thick portion of the atmosphere, scattering by air molecules removes the blue light, leaving the longer wavelengths of red, orange, and yellow to pass on through, creating the image of a ruddy or yellowish sun  **Q4:- What is Precipitation Processes**  **Sol)** Cloud droplet is extremely small, having an average diameter of 0.02 millimeters (mm), which is less than one-thousandth of an inch. Also, notice in Fig. 5.15 that the diameter of a typical cloud droplet is 100 times smaller than a typical raindrop. Clouds, then, are composed of many small droplets—too small to fall as rain. These minute droplets require only slight upward air currents to keep them suspended. Those droplets that do fall, descend slowly and evaporate in the drier air beneath the cloud. Condensation begins on tiny particles called condensation nuclei. The growth of cloud droplets by condensation is slow and, even under ideal conditions, it would take several days for this process alone to create a raindrop. It is evident, then, that the condensation process by itself is entirely too slow to produce rain. Yet, observations show that clouds can develop and begin to produce rain in less than an hour. Since it takes about 1 million average size cloud droplets to make an average size raindrop, there must be some 8/12 other process by which cloud droplets grow large and heavy enough to fall as precipitation. Even though all the intricacies of how rain is produced are not yet fully understood, two important processes stand out: (1) the collision-coalescence process (2) the ice-crystal (or Bergeron) process. COLLISION AND COALESCENCE PROCESS In clouds with tops warmer than –15°C, collisions between droplets can play a significant role in producing precipitation. To produce the many collisions necessary to form a raindrop, some cloud droplets must be larger than others. Larger drops may form on large condensation nuclei, such as salt particles, or through random collisions of droplets. Recent studies also suggest that turbulent mixing between the cloud and its drier environment may play a role in producing larger droplets. As cloud droplets fall, air retards the falling drops. The amount of air resistance depends on the size of the drop and on its rate of fall: The greater its speed, the more air molecules the drop encounters each second. The speed of the falling drop increases until the air resistance equals the pull of gravity. At this point, the drop continues to fall, but at a constant speed, which is called its terminal velocity. Because larger drops have a smaller surface-area-to-weight ratio, they must fall faster before reaching their terminal velocity. Thus, larger drops fall faster than smaller drops. Large droplets overtake and collide with smaller drops in their path. This merging of cloud droplets by collision is called coalescence. Laboratory studies show that collision does not always guarantee coalescence; sometimes the droplets actually bounce apart during collision. For example, the forces that hold a tiny droplet together (surface tension) are so strong that if the droplet were to collide with another tiny droplet, chances are they would not stick together (coalesce) (see Fig. 5.16). Coalescence appears to be enhanced if colliding droplets have opposite (and, hence, attractive) electrical charges.\* An important factor influencing cloud droplet growth by the collision process is the amount of time the droplet spends in the cloud. Since rising air currents slow the rate at which droplets fall, a thick cloud with strong updrafts will maximize the time cloud droplets spend in a cloud and, hence, the size to which they grow. Clouds that have above-freezing temperatures at all levels are called warm clouds. In tropical regions, where warm cumulus clouds build to great heights, 9/12 strong convective updrafts frequently occur. In Fig. 5.17, suppose a cloud droplet is caught in a strong updraft. As the droplet rises, it collides with and captures smaller drops in its path, and grows until it reaches a size of about 1 mm. At this point, the updraft in the cloud is just able to balance the pull of gravity on the drop. Here, the drop remains suspended until it grows just a little bigger. Once the fall velocity of the drop is greater than the updraft velocity in the cloud, the drop slowly descends. As the drop falls, some of the smaller droplets get caught in the airstream around it, and are swept aside. Larger cloud droplets are captured by the falling drop, which then grows larger. By the time this drop reaches the bottom of the cloud, it will be a large raindrop with a diameter of over 5 mm. Because raindrops of this size fall faster and reach the ground first, they typically occur at the beginning of a rain shower originating in these warm, convective cumulus clouds. So far, we have examined the way cloud droplets in warm clouds (that is, those clouds with temperatures above freezing) grow large enough by the collisioncoalescence process to fall as raindrops. The most important factor in the production of raindrops is the cloud’s liquid water content. In a cloud with sufficient water, other significant factors are: 1. The range of droplet sizes 2. The cloud thickness 3. The updrafts of the cloud 4. The electric charge of the droplets and the electric field in the cloud.  **Q5:- How Measuring Air Pressure?**  **Sol)** Up to this point, we have described air pressure as the mass of the atmosphere above any level. We can also define air pressure as the force exerted by the air molecules over a given area. Billions of air molecules constantly push on the human body. This force is exerted equally in all directions. Instruments that detect and measure pressure changes are called barometers, which literally means an instrument that measures bars. In meteorology, the bar is a unit of pressure that describes a force over a given area. Because the bar is a relatively large unit, and because surface pressure changes are normally small, the unit of pressure most commonly found on surface weather maps is the millibar (mb), where one millibar is equal to one-thousandth of a bar. A common pressure unit used in aviation and on television and radio weather broadcasts is inches of mercury (Hg). At sea level, the average or standard value for atmospheric pressure is 1013.25 mb = 1013.25 hPa = 29.92 in. Hg. BAROMETERS Because we measure atmospheric pressure with an instrument called a barometer, atmospheric pressure is also referred to as barometric pressure. Evangelista Torricelli, a student of Galileo’s, invented the mercury barometer in 1643. His barometer, similar to those used today, consisted of a long glass tube open at one end and closed at the other (see Fig. 6.4). The most common type of home barometer—the aneroid barometer—contains no fluid. Inside this instrument is a small, flexible metal box called an aneroid cell. Before the cell is tightly sealed, air is partially removed, so that small changes in external air pressure cause the cell to expand or contract. The size of the cell is calibrated to represent different pressures, and any change in its size is amplified by levers and transmitted to an indicating arm, which points to the current atmospheric pressure . Notice that the aneroid barometer often has descriptive weather-related words printed above specific pressure values. These descriptions indicate the most likely weather conditions when the needle is pointing to that particular pressure reading. Generally, the higher the reading, the more likely clear weather will occur, and the lower the reading, the better are the chances for inclement weather. Air Pressure and Winds This situation occurs because surface high pressure areas are associated with sinking air and normally fair weather, whereas surface low-pressure areas are associated with rising air and usually cloudy, wet weather. A steady rise in atmospheric pressure (a rising barometer) usually indicates clearing weather or fair weather, whereas a steady drop in atmospheric pressure (a falling barometer) often signals the approach of a storm with inclement weather. | | |