Lecture 14: Midterm Exam Review

Midterm Exam Format: Choose the best answer. 50 multiple choice questions (2 points each).

- Exam will be available: on Friday Oct. 27, 2023 between 6-9pm
- **Students are required to finish it <u>within 1 hour</u>.**
- Students will be able to see their scores immediately after the exam. The full results of the mid-term exam (all of the questions and correct answers) will be available on Nov. 13, 2023 for your final review.
- **Students can only have one attempt**

LECTURE 1: Overview of remote sensing

1. In-situ vs. remote sensor: Definition of each; difference between them; Examples
2. Active vs. passive remote sensor: Definition of each; difference between them; Examples
3. Remote sensing sensors vs. platforms: Examples

LECTURE 2: No questions

LECTURE 3: Atmospheric radiation basics

4. Definitions of shortwave and longwave radiation; their frequency bands.
5. Definition and characteristics of EM waves.
6. Definitions of frequency, wavelength, and wavenumber.
7. Understanding Planck-Einstein equation E=hf.
8. Solid angle: definition (no derivation), the solid angle for a whole sphere.
9. What is polarization

LECTURE 4: EM spectrum

10. EM bands that are important to remote sensing in meteorology. Need to know different usages of different wavelength bands.
11. Factors important to total insolation.

LECTURE 5: Emission

12. Know what is emission.
13. Definition of blackbody & its properties.
14. Know the physical interpretation of the Planck Function, Wien's law, Stefan-Boltzmann's law, & Rayleigh-Jeans approximation.
15. Definition of emissivity & Definition of graybody.
16. Definition of brightness temperature Tb. Characteristics of Tb at IR and microwave bands, respectively.

LECTURE 6: Absorption

17. Definition of absorption, absorptivity, absorption coefficient, mass absorption coefficient, optical path length, and transmissivity.
18. Kirchhoff's law: what it says, and when it is valid.
19. Lambert's law: understand what it tells us.

LECTURE 7: Scattering

20. Definitions of scattering. Know when to use reflection/refraction and when to use scattering.
21. Size parameter. Define Rayleigh, Mie, and Optics scattering regimes using the size parameter.
22. Difference of the angular distribution of scattering for Rayleigh and Mie regimes.
23. Definition of extinction.

LECTURE 8: Radiative transfer equation

24. Know which processes we need to consider in getting the radiative transfer equation, i.e., what are terms A, B, C, and D. Which are depletion terms, and which are source terms.
25. Non-scattering radiative transfer equation: valid in which regime.
26. Non-emission radiative transfer equation: valid in which regime.

LECTURE 9: Reflection and refraction

27. Definition of the complex index of refraction. What is the real part describing? What is the imaginary part describing? Which part is responsible for reflection and refraction? Which part is responsible for absorption?
28. When to use the rules of reflection & refraction in the atmosphere?
29. Know the relationship between incident angle and reflection angle
30. Know Snell's law
31. Explain rainbow: what is responsible for the primary rainbow?

LECTURE 10: Rayleigh and Mie scattering

32. Understand the 3 key facts derived from Rayleigh solution:
    a. For a fixed wavelength, larger particle will scattering more strongly (6 power of the radius or diameter). This is the basis of weather radar.
    b. Explain why the sky is blue.
    c. The fact relevant to passive microwave remote sensing of cloud water: absorption is proportional to mass path, independent on particle size.
33. Mie solution: understand Petty's book Fig. 12.4.

LECTURE 11: Introduction of Radar and Radar hardware

34. Know about radar antenna, reflector, feed born.
35. What determines the shape of the radar antenna bean pattern?
36. What is the true antenna?
37. Functions of transmitter, receiver, duplexer, signal processor.

LECTURE 12: Curvature and refraction of radar beam, radar equation for point targets

38. know how the radar beam bends relative to the Earth surface under standard refraction, sub-refraction, and super refraction conditions.
39. Definition of ducting.
40. In Rayleigh, Mie, and Optics regimes, how does the radar back-scattering cross section relate to the target (particle)'s size/diameter/geometric area.

LECTURE 13: Radar pulse Characteristics and Radar equation for distributed targets

41. Definitions of pulse length, listening time, range resolution, Pulse Repetition Frequency (PRF).
42. What determines the minimum range that radar could detect?
43. What determines the maximum unambiguity range that radar could detect?
44. Definition of radar reflectivity factor.