# YUSO 2017 Remote Sensing

## Exam Questions

You will have 50 minutes to complete the exam. Record all answers in the Answer Sheet packet, and do not write on this Exam Questions packet. Ties will be broken by questions 14, 32, and 22 in that order.

For questions 1 and 2, answer which type of sensor, active or passive, is best described by or is best suited for the description.

1. Receives signals reflected, refracted or scattered by Earth's surface and atmosphere.
2. Measures natural emissions produced by Earth's surface and atmosphere.

3. What does LiDAR stand for and what kind of pulse does it use as a signal?

For questions 4-8, answer which of atmospheric absorption, scattering or both best applies to the description.

4. Affects visible and near infrared regions
5. Attenuates reflected radiance
6. May produce a hazy appearance in the image captured by the sensor
7. Depends on radiation wavelength, size and concentration of atmospheric particles, and depth of atmosphere
8. Carbon dioxide, ozone and water vapor are primarily responsible for this effect

For questions 9-13, match the term to its description out of choices a-f.

9. Black body
10. Emissivity
11. Stefan-Boltzmann law
12. Planck's law
13. Wein's law

a. Black body radiation curves peak at a wavelength inversely proportional to the temperature
b. Describes black body spectral radiance as a function of its wavelength at a given temperature
c. Energy radiated by a black body is proportional to the fourth power of the black body's temperature
d. Effectiveness of a surface in emitting thermal radiation
e. Radiant flux reflected by a surface
f. Perfectly efficient absorption of electromagnetic radiation

14. List three climate-change-related remote sensing measurements that thermal imagery enables.

15. _____ radar, as often used for precipitation radars, can detect motion of rain droplets or other precipitation.

16. What seven satellites were successfully launched to form parts of the A-Train satellite constellation, and on what dates were they launched?

17. What is the ordering of the satellites in the current train, and by what time intervals are they separated?

18. Which government space agencies are major collaborators on the A-Train project? Give their

acronyms, full names, and the nations to which they belong.

19. From what is the name "A-Train" derived?

20. In what type of orbit are the A-Train satellites? By what is this type of orbit characterized? What major advantage does this type of orbit offer for remote sensing?

21. Which of the A-Train satellites is primarily designed to study atmospheric carbon dioxide concentrations? In what spectral bands does it take measurements, and for what is each band used? What type of instrument does this satellite use to take measurements of spectral bands? Of what type is its main telescope?

22. Which of the A-Train satellites uses a lidar, and what is the formal name of this instrument? For what is the lidar used? With what type of instrument does this satellite take measurements supplementary to the lidar data? For what is this instrument specifically used?

23. What is the unit of radiative forcing?

24. Which anthropogenic substance contributes second most to radiative forcing?

25. Anthropogenic effects on the distribution and abundance of this substance have had the opposite of effect of carbon dioxide for radiative forcing.

26. Which two meteorological and geological factors contribute the most to global surface albedo?

27. Which composite image was collated using thermal IR remote sensing data? (See Image Sheet)

28. For measuring SST, name two advantages of using either passive microwave radiation or thermal IR over the other. (2pts, 1pt per advantage listed)

29. Which radiation type does the AMSR-e satellite use?

30. Which factor interferes the most with passive microwave measurements of SST?
    a) Sea surface roughness
    b) Atmospheric temperature
    c) Columnar water vapor
    d) Cloud cover

31. This service (remss.com) collates satellite data to obtain a composite image of global SST. Name a satellite that this service could to create the composite image. (See Image Sheet)

32. Assume that the Earth is in thermal equilibrium. Approximating the energy radiated by the earth using the Stefan-Boltzmann Law, what does a simple climate model defined by the assumption of thermal equilibrium predict as the average temperature of the Earth? Approximate the solar insolation as $\sigma_0 \approx 1366\ W/m^2$ and the Stefan-Boltzmann constant as $\sigma \approx 5.67\ \times 10^{-8}$. Give your answer to the nearest tenth of a degree Kelvin.

33. Improve the approximation above by adding the Earth's albedo α to the simple model. Use a value of $\alpha = 0.3$ for the Earth's approximate average albedo. As above, predict the global equilibrium temperature of the Earth to the nearest tenth of a degree Kelvin. Given that the Earth's global average temperature is approximately 288 K, is this prediction more or less accurate than that of the first model?

34. Incorporate the effect of greenhouse gases on the energy radiated by the Earth using a dimensionless parameter $\epsilon$. $\epsilon$ is the greenhouse factor, which models the effect of greenhouse gases on the permittivity of the atmosphere and must fall in the range $0 < \epsilon < 1$. Taking $\alpha = 0.3$ as before, what value of $\epsilon$ correctly predicts the Earth's global average temperature of approximately 288 K? Round your answer to the nearest hundredth. In words, explain how the value of $\epsilon$ effects the predicted global equilibrium temperature. That is, how does raising or lowering $\epsilon$ effect $T$?