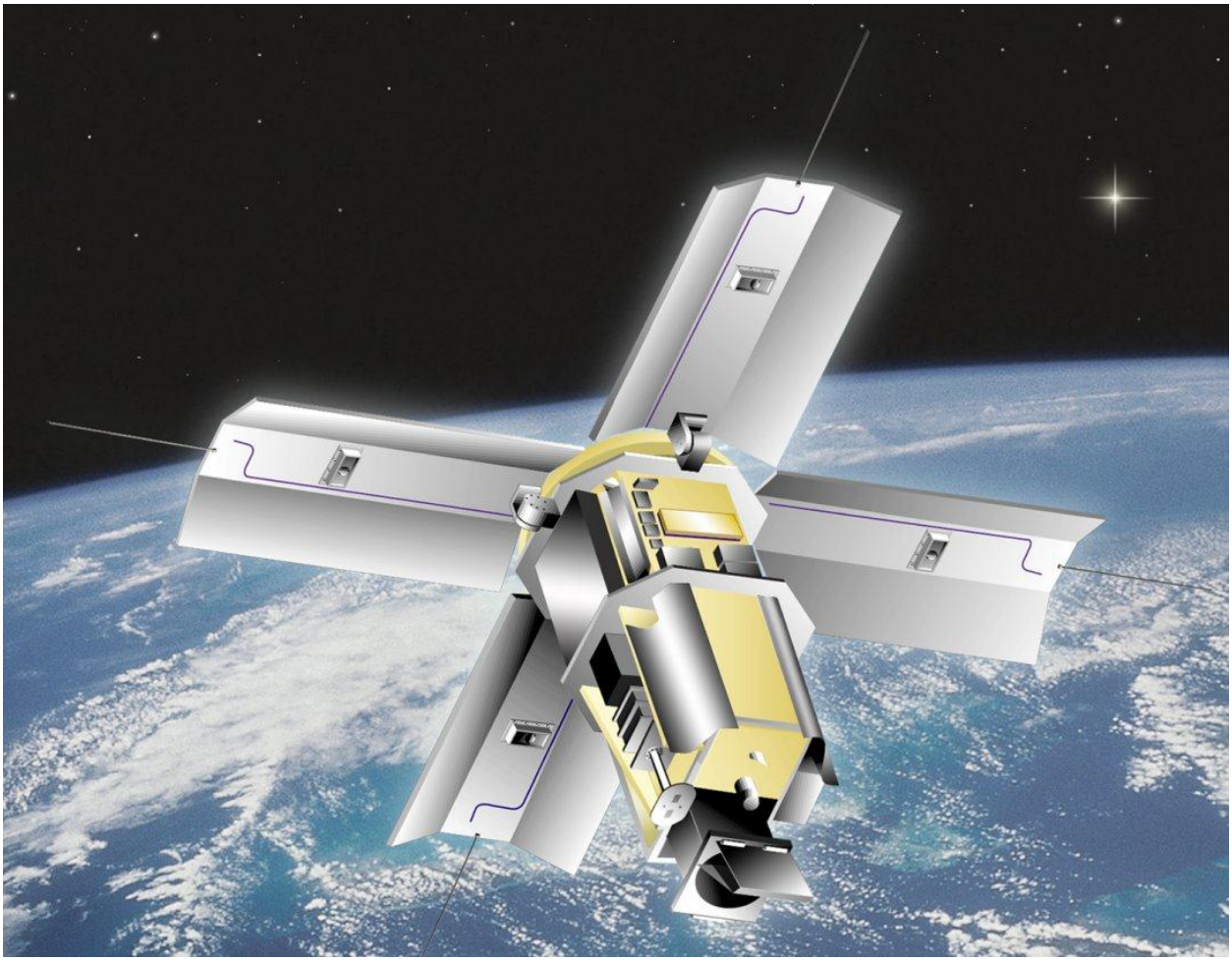
# Remote Sensing



School: _____

Team Number: _____

**Rules**

1. You are allowed 5 double-sided notes sheets as a resource for this event. You are also allowed *non-programmable* calculators, triangles, protractors, rulers, and magnifying glasses. Please place these materials on your desk for the supervisors to inspect.
2. Please **do not** write on the image sheet. Failure to adhere to this rule may result in disqualification.
3. Please do not start the exam until you are told to do so. When the event supervisor says time is up, time is up. Failure to stop working may result in disqualification.
4. You are allowed to take apart the exam during the test. However, make sure to put the pages back in their correct order when handing in the exam.
5. Make sure to read all the directions written throughout the exam.
6. The exam is 80 questions with three sections. The test is fairly long, so make sure you manage your time well.
7. If you have specific questions about the exam or the event in general, feel free to send us an email: Lauren Johnson (laurenjohnson2016@gmail.com) and Anup Singh (singha@sas.upenn.edu)

Section I: General Remote Sensing

1. What is the name of the scattering that makes the sky appear blue?
    a. Rayleigh Scattering
    b. Mie Scattering
    c. Nonselective Scattering
    d. Raman Scattering
    e. None of the above

2. Which of the following describes the relationship between wavelength and frequency?
    a. Wavelength is inversely proportional to frequency.
    b. Frequency decreases as the wavelength goes up.
    c. Wavelength increases proportionally to the increase in frequency.
    d. Both a and b
    e. Both b and c

3. Which of the following choices shows the correct order of *decreasing* wavelength from the electromagnetic spectrum?
    a. Microwave, UV, Infrared, Visible, Radio
    b. Radio, Microwave, UV, Visible, Infrared
    c. Radio, Microwave, Infrared, Visible, UV
    d. Infrared, Microwave, Radio, UV, Visible
    e. None of the above

4. Which of the following best describes scattering?
    a. Absorption of light waves based on their energy content.
    b. Ability for incident radiation to transfer through a substance.
    c. Redirection of incoming radiation by particles in the air.
    d. The emission of low energy wavelengths by heated objects.
    e. Both a and d

5. What is a false color image also known as?
    a. Panchromatic film
    b. Color-infrared
    c. Thermal-infrared
    d. UV image
    e. Both b and c

6. In false color images, vegetation appears:
    a. Blue
    b. Green
    c. Red
    d. Yellow
    e. Black

7. LIDAR is an acronym for:
    a. Light Detection and Ranging
    b. Light Detection and Reflection
    c. Low Detecting and Reflecting
    d. Light Deflection and Reflection
    e. Low Density and Radiometry

8. What is the most *prevalent* greenhouse gas in the earth's atmosphere?
    a. Carbon Dioxide
    b. Water Vapor
    c. Methane
    d. Nitrous Oxide
    e. Ozone

9. Images sometimes appear slightly to the west of each previous scan due to the eastward rotation of the Earth. This is due to:
    a. Skew distortion
    b. Relief displacement
    c. Tangential scale distortion
    d. Foreshortening
    e. None of the above

10. An object with an emissivity less than 1 is called a:
    a. Blackbody
    b. Graybody
    c. Selective Radiator
    d. All of the above
    e. None of the above

11. A pulse of light is sent down from a sensor (using lidar) toward Earth. The sensor is orbiting the earth from a distance of approximately 80 km. The pulse is intended to measure the height of a mountain. If the pulse takes .0005 seconds to reach the mountain and get back (to the sensor), how high is the mountain (take the speed of light to be $3 \times 10^5$ km/s)?
    a. 1.8 km
    b. 2.0 km
    c. 3.0 km
    d. 5.0 km
    e. 6.1 km

12. The output from a thermal sensor is a measurement of the _____ temperature of an object:
    a. Kinetic
    b. Radiant
    c. Blackbody
    d. Infrared
    e. None of the above

13. A satellite sensor with the ability to sense small energy differences is known to have a high:
    a. Spatial resolution
    b. Spectral resolution
    c. Radiometric resolution
    d. Temporal resolution
    e. All of the above

14. As the IFOV of a sensor is decreased, the:
    a. Spatial resolution increases
    b. Radiometric resolution increases
    c. Temporal resolution increases
    d. Spectral resolution increases

15. What does a *dichroic grating* do in satellite systems?
    a. Separates thermal and nonthermal energy
    b. Separates incident energy into bands 1 and 2
    c. Disperses the thermal energy through a prism
    d. B and C
    e. None of the above

16. Which type of satellite systems are linear arrays used on?
    a. Along-track scanners
    b. Pushbroom scanners
    c. Across-track scanners
    d. Whiskbroom scanners
    e. A and B
    f. B and C
    g. C and D
    h. A and D

17. What are these linear arrays (referenced in #15) principally made up of?
    a. Photodiodes
    b. Digital cameras
    c. Charge-coupled devices
    d. Photographic film
    e. Liquid helium

18. A multispectral scanner is mounted aboard an airplane which is at an altitude of 15,000 meters above the ocean. If the IFOV of this system is 0.25 radians, what is the ground area viewed by this sensor? (Hint: $D = H'\beta$)
    a. 1.1 $km^2$
    b. 11 $km^2$
    c. 110 $km^2$
    d. 11,000 $km^2$
    e. 110,000 $km^2$

19. The observation that water has roughly uniform surface temperatures throughout the day and night means that water has a high:
    a. Thermal capacity
    b. Thermal inertia
    c. Thermal conductivity
    d. Thermal crossover
    e. A and D

20. Which of the following best describes the process of *binning*?
    a. Reduction of noise
    b. Increases imaging capacity and speed
    c. Changing data to graphic form
    d. Elimination of geometric irregularities on images
    e. Both b and c
    f. None of the above
    g. All of the above

21. In terms of resolution, *binning*:
    a. Increases spectral resolution
    b. Increases spatial resolution
    c. Increases radiometric resolution
    d. Increases temporal resolution
    e. Does not affect resolution

22. The instrument SeaWinds was/is aboard which satellite?
    a. SeaWiFS
    b. QuikSCAT
    c. Jason-1
    d. Nimbus 7
    e. NOAA-N Prime

23. In a linear contrast stretch, which of the following aspect(s) of the image are always changed?
    a. Size of pixels
    b. Brightness of pixels
    c. Color of pixels
    d. All of the above
    e. A and B

24. An orthophoto is useful because of its:
    a. High spatial resolution
    b. Enhanced topographic relief
    c. Camera tilt
    d. Uniform scale
    e. None of the above

25. Clumping digital number values of a specific range into a single value is best known as:
    a. Registration
    b. Digital merging
    c. Density slicing
    d. Destriping
    e. Linear data transformation

26. Which of the following are examples of non-imaging microwave sensors?
    *I. Altimeter* *II. Scatterometer* *III. SAR* *IV. SLAR*
    a. I only
    b. II only
    c. III only
    d. I and II
    e. II and III
    f. I, II, and IV
    g. I, II, and III

27. In RADAR systems, the antenna measures the amount of energy that is:
    a. Absorbed
    b. Transmitted
    c. Backscattered
    d. Converted to heat
    e. None of the above

28. Satellites in the Earth-Observing system typically have:
    a. Geosynchronous orbits
    b. Sun-synchronous orbits
    c. Molniya orbits
    d. Low Earth orbits
    e. B and D
    f. A and C

29. What is the name of the largest artificial satellite ever to orbit the earth?
    _____

Section II: Satellites

30. Which of the following satellites failed to reach orbit?
    a. OCO
    b. Glory
    c. Aqua
    d. SEASAT
    e. All of the above
    f. A and B

31. The Tropical Rainfall Measuring Mission carries all of the following sensors EXCEPT:
    a. VIRS
    b. TMI
    c. CERES
    d. CPR
    e. LIS

32. Which of the following sensors is considered the "workhorse" of TRMM?
    a. VIRS
    b. TMI
    c. CERES
    d. CPR
    e. LIS

33. On which satellite(s) does ASTER reside upon?
    a. Aqua
    b. Aura
    c. Terra
    d. Landsat 7
    e. A, B, C
    f. A and C

34. Which of the following best describes ASTER?
    a. Low spectral resolution radiometer imaging in near-IR.
    b. Thermal scanner with the highest known radiometric resolution
    c. High spatial resolution radiometer imaging in visible to thermal infrared.
    d. Microwave sensor used to measure water vapor content
    e. All of the above

35. The Microwave Limb Sounder is currently aboard which satellite?
    a. Aqua
    b. Aura
    c. Terra
    d. CALIPSO
    e. CloudSat

36. The Microwave Limb Sounder measures naturally occurring thermal emission from the limb of the earth's atmosphere. Which of the following words can be substituted for "limb"?
    a. Top
    b. Bottom
    c. Edge
    d. Principal axis
    e. None of the above

37. The satellite series SPOT was initiated by:
    a. JAXA
    b. NASA
    c. CNES
    d. ESA
    e. El-Op

38. The SPOT satellite series utilizes which major instrument?
    a. Laser Retroreflector
    b. Total Ozone Mapping Spectrometer
    c. Advanced Very High Resolution Radiometer
    d. High Resolution Visible
    e. Microwave Radiometer

39. Which satellite group would most likely image the effects of the earthquake and tsunami in Japan?
    a. Meteor series
    b. Feng Yun series
    c. SPOT
    d. DMC
    e. GOES series
    f. Landsat series

40. Which of the following satellites is NOT in the Morning Constellation?
    a. SAC-C
    b. Terra
    c. Landsat 7
    d. EO-1
    e. All of the above are in the Morning Constellation

END OF SECTIONS I & II

Section III: Image Interpretation

*Refer to Image A for Questions #41-47.*

41. What is the central feature in this image?
    a. Lake
    b. meteor impact crater
    c. mound with unidentified geologic cause
    d. copper mine
    e. Superfund site

42. Is this a true color image?
    a. Yes
    b. No
    c. Need more information

43. What accounts for the unusual color of the central feature?
    a. the colors chosen by the analyst
    b. differences in elevation
    c. algal blooms
    d. pollution
    e. high salinity

44. What is the non-dimensional scale of this image?
    a. 1 inch = 10.67 miles
    b. 1.9 cm = 8 miles
    c. 1:674,000
    d. 1:725,000
    e. 1:858,000

45. What is the approximate surface area of the central feature (include white portions)?
    a. 100 square miles
    b. 200 square miles
    c. 500 square miles
    d. 800 square miles
    e. 1000 square miles

46. This image was taken by Landsat 5 using the TM instrument. Landsat 7 carries the ETM+ instrument. What was an improvement over TM does ETM+ have?
    a. Two SWIR bands instead of one
    b. NIR range is broadened to .75-.9 µm NIR
    c. .52-.9 µm panchromatic band
    d. Extra temperature probes were added
    e. All of the above

47. What TM bands were used to create this image?
    a. 1, 2, 3
    b. 1, 3, 5
    c. 1, 3, 7
    d. 5, 6, 7
    e. All of the above

*Refer to Image B for Questions #48-53.*

48. Is this a false color image?
    a. Yes
    b. No
    c. Need more information

49. What do dark green areas indicate?
    a. Agriculture
    b. intact forest
    c. flooded wetlands
    d. human development
    e. two of the above

50. What do light green areas indicate?
    a. areas cleared for palm oil plantations
    b. desertification
    c. return to native vegetation
    d. grassland
    e. two of the above

51. Identify what is occurring at the area labeled A.
    a. chemical pollution
    b. sediment runoff
    c. high iron content
    d. phytoplankton bloom
    e. none of the above

52. True or False: Agricultural practices in this area are responsible for the phenomenon you selected in the previous question.
    a. True
    b. False
    c. Not enough information

53. What is the non-dimensional scale of this image?

*Refer to Image C for Questions #54-60.*

54. What is located at A?
    a. Farms
    b. golf course
    c. solar panel test area
    d. residential area

55. What is located at B?
    a. School
    b. sheep farm
    c. golf course
    d. baseball fields
    e. nothing

56. What is located at C?
    a. Airport
    b. School
    c. industrial complex
    d. lake
    e. nothing

57. What of these features is also visible in this image?
    a. wastewater treatment plant
    b. baseball diamond
    c. track
    d. two of the above
    e. all of the above

58. What biome is the setting for this image?
    a. Desert
    b. Rainforest
    c. Grassland
    d. Taiga
    e. none of the above

59. What is the non-dimensional scale of this image?
    a. 1 cm = 500 m
    b. 1 cm = 2,000 ft
    c. 1:200
    d. 1:37,000
    e. 1:50,000

60. How far, in meters, is it from the letter A to the letter C?
    a. 400 ft
    b. 2,000 m
    c. 2,700 m
    d. 3,300 m
    e. 4,000 m

*Refer to Image D for Questions #61-65.*
*This image shows the Drygalski Ice Tongue. The red line is from 2002, and the blue line is 1988.*

61. How far has the Drygalski Ice Tongue grown in the period shown?
    a. 1 km
    b. 8 km
    c. 10 km
    d. 15 km
    e. It has not grown at all, but has shrunk due to global warming.

62. What is the percent change in area of the Tongue?
    a. 0 %
    b. 20%
    c. 30%
    d. 40%
    e. It has lost 20% of its area.

63. What is the rate of growth of the Tongue in meters per day?
    a. 1 m/day
    b. 2 m/day
    c. 4 m/day
    d. 8 m/day
    e. It has lost 4 m/day.

64. The Drygalski Ice Tongue is part of a glacier. As the Earth warms due to global warming, glaciers are melting. What impact might the melting of glaciers have?
    a. rising sea level
    b. positive feedback loop resulting in more glacial melting
    c. changes in ocean salinity
    d. two of the above
    e. all of the above

65. What satellite would be best-suited to monitor the melting of glaciers?
    a. OCO
    b. Landsat-7
    c. DMSP
    d. SeaStar (which contains SeaWiFS)
    e. GRACE

*Refer to Image E for Questions #66-72.*

66. What does the color red indicate in this image?
    a. many small aerosols
    b. few small aerosols
    c. many large aerosols
    d. few large aerosols
    e. healthy vegetation
    f. None of the above

67. What gas is often a secondary indicator of high aerosol concentration? (And can help scientists determine the source of aerosols.)
    a. Water
    b. Methane
    c. Carbon Monoxide
    d. Oxygen
    e. Nitrogen
    f. All of the above

68. What information could give also you a hint about the source of aerosols?
    a. time of year
    b. size of the particles
    c. location of the particles
    d. a and c only
    e. a and b only
    f. b and c only
    g. all of the above

69. The source of aerosols in Africa in the image above is the burning of vegetation to clear new land for crop planting. In general, this practice can encompass what is referred to as slash-and-burn agriculture. Which of the following are negative consequences of this practice?
    a. Desertification
    b. drastically increased rainfall
    c. decrease in soil nutrient content
    d. a and b only
    e. b and c only

70. Sulfur aerosols:
    a. can result in global dimming
    b. can result in global cooling
    c. are only released into the atmosphere in large quantities by humans
    d. a and b only
    e. b and c only

71. Black carbon is an aerosol that can:
    a. decrease the albedo of the atmosphere
    b. decrease the albedo of ice
    c. result in surface cooling
    d. a and c only
    e. all of the above

72. MODIS and AVHRR have both been used to study aerosols. What are some advantages MODIS has (over AVHRR)?
    a. higher spatial resolution
    b. greater spectral resolution
    c. greater swath width
    d. a and b only
    e. all of the above

*Refer to Image F for questions #73-80.*

73. What is being measured in the top image?
    a. amount of reflected energy
    b. amount of outgoing energy
    c. areas experiencing cooling
    d. areas experiencing warming
    e. cloud cover

74. What is being measured in the bottom image?
    a. amount of reflected energy
    b. amount of outgoing energy
    c. areas experiencing cooling
    d. areas experiencing warming
    e. cloud cover

75. What part of the IR spectrum was used to form these images?
    a. Visible
    b. Infrared
    c. Microwave

76. True or false: Clouds can help cool and warm the Earth.
    a. True
    b. False
    c. Clouds do not impact the Earth's climate
    d. Not enough information to tell

77. The instrument that took this image, CERES, is located on Suomi NPP. What other satellite has the same instrument?
    a. Landsat-7
    b. TRMM
    c. Terra and Aqua
    d. ERBS
    e. b and c only

78. What type of scanner is CERES?
    a. across-track
    b. along-track
    c. Rotating Azumith Plane
    d. all of the above

79. Which channel on CERES specifically measures reflected sunlight?
    a. 0.3 - 5.0 μm (Shortwave)
    b. 8 - 12 μm (Longwave)
    c. 0.3 to > 100 μm
    d. none of the above

80. Suomi NPP orbits at 824 km and 98.7°. What type of orbit is this?
    a. Geostationary
    b. sun-synchronous
    c. Molniya
    d. near-polar
    e. b and d only

**END OF EXAM**