

Part 1 is to be answered without material. Students can open books after returning answers for part 1.

Part 1. Closed book.

1. (6 p) Explain these terms without material
 - a) SAR
 - b) Geosynchronous orbit
 - c) Speckle
 - d) Brightness temperature
 - e) Dicke radiometer
 - f) Pushbroom scanning

Part 2. Open book.

2. (6 p) Derive the bistatic radar equation. Explain all the steps and the used parameters. What part of this equation describes the target? What is it called? How the target properties influence on the radar measurement?
3. (6 p) Microwave radiometer is calibrated before and right after the measurement flight with both cold and hot load. Liquid nitrogen of temperature 77 K was used as a cold load. Before the flight the air temperature was 10° C and after 13°C. Before the flight the measured output voltage was 10 mV (cold) and 35 mV (hot) and after the flight 11 mV (cold) and 47 mV (hot). Halfway of the measurement flight the radiometer measured forest with output reading of 29 mV. What was the brightness temperature of the forest?
4. (6 p) POES satellites are located in polar orbit at 830 km altitude with 75° inclination. The swath width is 2600 km. What is the orbital period? What is the orbital velocity? How long would it take this system to acquire full coverage at the equator if the instrument is using both ascending and descending passes?
5. (6 p) The pulse length of an airborne SAR-radar is 40 ns. What is the resolution on the ground, when flight height is 2 km, incidence angle is 25° and the antenna size is 1× 2 m (width × height)? With focused SAR one can assume that the resolution along-track is $\rho_x = D/2$.

Calculate also signal-to-noise ratio, if radar is sending only one pulse and the target reflector has radar cross-section of 10 m². The reflector is in the middle of lawn, which has differential scattering coefficient of 0.15. Noise temperature of the radar is 500 K, frequency 9.5 GHz, bandwidth 25 MHz and transmitted power is 5 kW.