Final Exam: Geophysical Glaciology (Ice Penetrating Radar)

1) How does doubling the transmit power of an ice penetrating radar system affect its SNR relative to thermal receiver noise?

2) How does doubling the transmit power of an ice penetrating radar system affect its SNR relative to speckle?

3) How does doubling the antenna gain of an ice penetrating radar system affect its SNR relative to thermal receiver noise?

4) If the gain of the first low noise amplifier in a radar receiver is 10 dB, about how many times more important is its noise figure to the total receiver noise than the noise figure of the second amplifier?

5) How can two 12-bit digitizers be used to increase the total dynamic range of a radar receiver? What is the combined dynamic range if a 5 dB overlap is required between the digitizers?

6) What is the maximum Doppler frequency for a platform moving at 50 m/s at a survey height of 700m?

7) What portion of the incident radar energy would be reflected from a water body with a relative permittivity of 80 and a loss tangent of 1 beneath glacial ice with a relative permittivity of 3.17 and a loss tangent of 0.062?

8) If measure received radar signal with a peak-to-peak voltage 30 mV on a 50-Ohm co-axial cable, what is the received power in dBm?

9) If antenna array that is used for both transmitting and receiving a radar signal has a 10dB gain at nadir, how many times stronger a returned signal be using that array than a return using an antenna with an isotropic beam pattern?

10) One radar equations for IPR has a 1/R^2 term and one has a 1/R^4 term, why?

11) How many time greater would you expect the scattering loss to be from a volume of spherical scatterers with radii of approximately $1/10^{th}$ of a wavelength than from a volume of scatters with radii of approximately $1/5^{th}$?

12) What is radar cross section?

13) Describe what makes a radar system, processing technique, and target coherent or incoherent.

14) Describe the impact that ice surface roughness has on the coherence of returns from englacial interfaces.

15) What is the difference between signal power, bandwidth, and information?

16) What sampling rate is required to satisfy the Nyquist criteria for a signal given by f(t) = 60*20(t-0.5)*(H(t)-H(t-1)), where H is the Heavyside step function, f is in MHz, and t is in microseconds?

17) Assume that you have an aircraft with a survey velocity of 50 m/s and a survey height of 600m with an ice penetrating radar system with a center frequency of 100 MHz and a PRF of 10 KHz. How much stacking can be performed without the potential of aliasing the surface?

18) Sketch the output of an azimuth FFT and a range FFT on the radar return from an isotropic point scatterer beneath a moving airborne radar system.

19) How would you explain what SNR is to a scientifically literate non-expert?

20) Explain the relative effect of coherent and incoherent processing on signal to noise ratio for noise resulting from the thermal noise of the receiver.

21) Explain the relative effect of coherent and incoherent processing on signal to noise ratio for noise resulting from speckle.

22) Explain the relative effect of coherent and incoherent processing on signal to noise ratio for noise resulting from galactic noise.

23) Explain the difference between SNR and SCR?

24) Describe how both geometric optics and physical optics can be used to predict the strength of a radar return from a rough surface.

25) Explain how volume scatters be thought of sources of signal, noise, and loss.

26) Why are most statistical methods for quantitatively characterizing surface roughness from radar data poorly suited to measuring the size of crevasses?

27) What is the in-ice range resolution for a radar system with a center frequency of 50 MHz and a bandwidth of 10 MHz?

28) What is the diameter of the first Fresnel zone at the bed for a survey height of 1000m, an ice thickness of 200m, and a radar center frequency of 2 MHz?

29) What is the Doppler resolution for a point on the surface that has been observed with a dwell-time of 2 minutes?

30) Is the first Fresnel zone larger on the ice surface or the ice bed for ice 4 km thick observed from a survey height of 100m?

31) If an airborne radar has pulse-limited footprint with a diameter of 500m on the surface, what is the largest potential diameter of its first Fresnel zone?

32) What is the along-track resolution for radar with a survey height of 400m, center frequency of 2MHz, bandwidth of 1MHz, and focusing aperture of 2km?

33) Describe the difference between coherent and incoherent processing from the perspective of geometric and radiometric resolution.

34) What is the effect of coherently summing two traces on SNR relative to additive noise and multiplicative noise?

35) What is the effect of incoherently summing two traces on SNR relative to additive noise and multiplicative noise?

36) Sketch an unprocessed radargram and a Doppler-filtered radargram for region of an ice sheet with a variety of layer slopes and surface clutter.

37) Explain the difference between multi-looking and focusing.

38) Why is it so common for ice penetrating radar systems both use and perform matched-filtering on LFM (or chirped) waveforms?

39) Discuss the trades involved with choosing a radar center frequency in terms of scattering, SNR, and resolution.

40) Diagram the steps involved in range-migrated SAR focusing of IPR data.

41) How is focusing ice penetrating radar different than focusing surface SAR?

42) Why does the UTIG Airborne IPR program call its two focused products "1D" and "2D" and how are they different?

43) What processing is involved in producing what the UTIG Airborne IPR program call "pik1" and how is it different from unfocused SAR?

44) What glaciological targets are best observed using focused radar data?

45) What glaciological targets are best observed using unfocused radar data?