GX1153

National University of Ireland, Galway
OLLSCOIL NA hÉIREANN, GAILLIMH

SUMMER EXAMINATIONS 1999

MSc Examination

Applied Geophysics

Paper Two

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Time allowed : Three hours

Answer Question 1, and any **three** of the remaining six.

1A. Select the answer or answers which you believe to be correct.

(a) Cos 2π ft

(i) is an even function
(ii) is an odd function
(iii) has a complex Fourier transform
(iv) is band limited

(b) Convolution in the time domain is equivalent to:

(i) correlation in the space domain
(ii) multiplication in the frequency domain
(iii) multiplication in the wavenumber domain
(iv) autocorrelation in the time domain

(c) The reflection coefficient for an upgoing P wave at the water-air interface is approximately:

(i) +0.5
(ii) -0.5
(iii) +1.0
(iv) -1.0

(d) A top layer of velocity 2kms^{-1} overlies a basement of velocity 3kms^{-1}. If the cross-over distance is 67m, what is the thickness of the layer?:

(i) 33.5m

(ii) 30m

(iii) 15m

(iv) 7.5m

(e) The critical distance in (d) is:

(i) 7.5m

(ii) 15.0m

(iii) 26.8m

(iv) 33.5m

1B. Write short notes on the following topics:

(a) Acoustic impedence

(b) AVO

(c) Geophone arrays

(d) The plus-minus method

(e) Velocity analysis

2. Describe the z-transform notation for representing a discrete time series, and show how it can be used to find the convolution of two digital signals. Hence, show how the z-transform can be used to describe the operation of digital filters, and how z-transform methods can help find the inverse of a digital filter. What are the conditions for a stable inverse filter?

In practice, any realisable filter will have a finite number of terms. What methods have been developed to minimise the resultant error.

3. The digitisation of a continuous time signal can be regarded as multiplication by a Dirac comb. Using this approach, explain how aliasing can arise, and use your discussion to define the condition for aliasing to be avoided. In doing so, make sure to define the terms, sampling frequency, folding frequency, and Nyquist frequency.

Describe how the effects of aliasing can be minimised when time signals are digitised, and briefly discuss the corresponding problem in the space domain.

4. Describe the convolutional model of the seismic trace. List the assumptions it makes, and compare them with reality.

The model can be applied in two rather different areas; one in estimating the reflectivity sequence, and one in generating synthetic seismograms. Discuss one of these applications.

5. Describe the time-distance equation for a reflection raypath in a single layer of thickness h, velocity V, and with horizontal boundaries. Sketch the resulting time-distance graph, and use it to define the term normal moveout (NMO).

Normal move-out plays a crucial role in reflection seismology. Explain why, and use it to describe how the common depth point (CDP) method for reflection seismology is developed. Pay attention to both acquisition and processing.

6. Describe the main features of a marine multi-channel seismic data acquisition system, mentioning air-gun arrays, streamers, ship speed, shot spacing, and navigation.

Modern vessels are equipped for multi-streamer work and 3-D acquisition. Describe these developments and explain how they enhance the value of a survey.

7. Outline the basic principles of seismic reflection interpretation, by listing the steps which an interpreter must take to move from the raw data in the form of a CDP time section to a geological interpretation. What pitfalls must the interpreter be aware of, and what other (non-seismic) data might be brought to bear?