NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

APPLIED PHYSICS DEPARTMENT

MAPH 5239 – REFRACTIONAL AND REFLECTIONAL SEISMIC METHODS

MSc GEOPHYSICS PART I ***DURATION: 4 HOURS***

ANSWER **ALL** QUESTIONS.

1. (a) List five areas of application of the refractional seismic method accompanied by a one sentence comment on each application. [5]

   (b) Distinguish with the aid of a diagram between the terms '*cross-over distance'* and 'critical distance' in the case of a single horizontal interface at depth $\boldsymbol{h}$ between two beds with different elastic properties. [7]

   (c) Explain with the aid of diagrams the *Time – depth* method for the interpretation of seismic refraction data for the case of a single horizontal refracting horizon. [6]

   (d) Show that for (c) above the intercept time t_i is given by:

   $$\boldsymbol{t_i = z \cos \theta_c / v_1}$$

   where the symbols have their usual meanings. [7]

2. (a) Draw a clear diagram and write down an expression for Snell's law for seismic waves refracted/reflected at an interface at which conversion occurs. Under what condition will a plane wave suffer no conversion at a plane interface? [5]

   (b) For the case of a wave critically refracted at an interface dipping at an angle α to the horizontal:

   (i) draw a time – distance graph; [4]
   (ii) derive the expression for the travel time of the head wave from the source to a receiver a distance x away. [6]

   (c) Use the result from (b) above to find the true velocity of the bottom layer and its dipping angle. Derive the expressions for both. [10]

3. (a) Define the terms *stress* and *strain*.
   Express the stress and strain related by each of the following elastic constants:

(i) Young's modulus (ii) Poisson constant
(iii) rigidity modulus (iv) bulk modulus [7]

(b) Derive an exact expression for *normal moveout* (NMO) in terms of offset; two-way time and the velocity of a homogeneous layer overlying a horizontal reflector.

What is the purpose of the NMO correction as applied to
(i) single fold continuous coverage; and
(ii) multiple fold CDP data? [9]

(c) Why are geophone arrays used in seismic reflection prospecting? [4]

4. Write explanatory notes on the following topics:

(a) Ground roll and methods for its suppression in reflection records; [5]

(b) CDP techniques – its advantages and disadvantages; [5]

(c) velocity spectrum (how is it constructed and applied to reflection seismic data) [5]

5. (a) Explain the $t^2 - x^2$ method for measuring the seismic velocities of two or homogeneous layers separated by horizontal interfaces. State the assumptions and approximations required. Define the terms *RMS velocity* and *interval velocity.* [8]

(b) A $t^2 - x^2$ analysis gives the following values for horizons A, B and C:

horizon	two-way time (s)	RMS velocity (m/s)
A	2.1	2900
B	2.6	3200
C	3.3	3700

Find the interval velocity for AB and BC. [7]

END OF EXAMINATION