

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

APPLIED PHYSICS DEPARTMENT

MAPH 5135 - THEORY OF SEISMOLOGY

MSc PART 1: DECEMBER 2005

DURATION: 4 HOURS

Attempt all questions. The maximum possible mark is 100 points.

NOTE: You are encouraged to make use of sketches to further illustrate your answers where possible.

1. From Hooke's law, derive the relations for

a. Modulus of rigidity [9]

b. Young's modulus and [7]

c. Poisson's ratio. [4]

2. From the equations of motion, show that for a wave travelling in an homogeneous layer, the longitudinal and transverse velocities are given respectively by

a. $\alpha = \sqrt{\frac{\lambda + \mu}{\rho}}$ [10]

b. $\beta = \sqrt{\frac{\mu}{\rho}}$ [5]

where λ and μ are Lamé constants.

3. Seismic wave velocity is known to vary with depth, and the density of material in the earth is believed to vary with depth. Discuss with the aid of sketch diagrams the seismic velocity – depth models for P and S waves. With reference to the Adams-Williamson relation discuss the density – depth profile for the whole earth. [20]

a. With the aid of sketch diagrams of ray paths and travel times, explain the existence of at least two cases of the “*shadow zone*” that results from a low velocity zone. [10]

b. PKP seismic waves are known to exist for earthquakes over epicentral distances of 143° to 188° while PKIKP waves are observable over distances starting from 110° to 180° . Briefly discuss these phenomena with the aid of sketch diagrams. [10]

4. In tabular form, compare and contrast, Rayleigh and Love waves. [5]

5. Outline the relevant steps taken in using the Herglotz – Wiechert integral in inversion seismic problems to determine the radius at which the ray reaches the bottom. When does this method fail ? [10]

6. For the strain tensor $\sigma_{ij} = \begin{bmatrix} 3 & 0 & 0 \\ 0 & 1 & 1 \\ 0 & 1 & 2 \end{bmatrix}$ find

- a. the corresponding stress tensor assuming an isotropic solid with Lamé constants λ and μ . [5]
- b. the stored elastic strain energy [5]

END OF EXAMINATION