

M. SC. APPLIED GEOLOGY EXAMINATION, 2023

(1st Year, 2nd Semester)

TECTONICS AND SOLID EARTH GEOPHYSICS

PAPER – CORE/TH/05

Time : Two hours

Full Marks : 40

(Use a separate Answer script for each Part.)

Part – I (20 Marks)

Answer *any four* questions.

1. a) Write the mathematical expressions of a diffusion equation and a wave equation, and explain the fundamental differences in terms of their physical meaning.
b) Show that the shear wave velocity in an elastic medium is $\left(\frac{\mu}{\rho}\right)^{\frac{1}{2}}$, where μ is the shear modulus and ρ is the density of the medium. 2+3=5
2. a) Prove that, under the steady state thermal condition of a solid substance the temperature will satisfy Laplace equation. Assume there is no heat source in the medium.
b) Derive the heat equation for a two-dimensional system with a heat source. Consider that the heat flows by a combination of conduction and advection. 3+2=5

[Turn over

[2]

3. a) Explain how a fluid medium can undergo a thermal change at the critical condition leading to the onset of convection.
- b) Express Navier–Stokes equations for a fluid layer taking into account a thermally induced density fluctuation. Consider the layer as a two-dimensional system in Earth’s gravity field. 3+2=5
4. a) Define the term: stream function.
- b) Show that the heat accumulated in a unit area by advection is: $\rho c \left(u \frac{\partial T}{\partial x} + v \frac{\partial T}{\partial y} \right)$, where u and v represent advection velocity components, T is the temperature, ρ is the density and c is the specific heat of the medium. 2+3=5
5. a) Explain the critically stable state of a fluid layer subjected to heating.
- b) Prove that the convection instability in the fluid layer will occur on a wavelength of $2\sqrt{2}b$, where b is the thickness of the fluid layer. 3+2=5
6. a) Write the mathematical expression of an initial mechanical perturbation imposed at the interface of two layers of contrasting densities in the theoretical analysis of gravitational instabilities. Justify the expression.

[3]

- b) How are the boundary conditions chosen in deriving the Stokes formula? 3+2=5

Part – II (20 Marks)

1. Answer **any two** questions : 10×2=20
- i) Describe in detail the geophysical processes by which you can establish the tectonic evolution of a cratonic block. 10
- ii) a) How do you explain the surface magnetic field with respect to temporal variation? 5
- b) How does a crustal rock get magnetized? 5
- iii) Explain the schematic trends and transitions of χ values from -196°C to 700°C for different minerals and domains; SP, SSD, MD, paramagnetic (P), magnetite (MAG), titanomagnetite (TMAG) and haematite. 10
- iv) Describe the tectonic implications of a crustal rocks on the basis of generations of Fe-Ti oxides during high and low temperature oxidations. 10