

Branch – MATHEMATICS

COMPRESSIBLE FLOW & MHD

Time: Three Hours

Maximum: 75 Marks

Answer ALL questions

ALL questions carry EQUAL marks

(5×15=75)

1. a Derive the equation of continuity for a multidimensional compressible fluid. (5)
b Derive the Bernoulli's equation for compressible fluids. (10)
OR
c State and prove Kelvin's theorem for compressible fluids. (7)
d Write down the physical significance of the Mach number, Mach line and Mach cone. (8)
- 2 a Discuss about plane Couette flow. (7)
b Find the temperature of velocity distributions in Couette flow. (8)
OR
c Obtain the momentum integral equation of the boundary layer in compressible fluids. (8)
d Obtain the integral relation of the energy equation in compressible fluids. (7)
- 3 a State and prove Alfven's theorem. (8)
b Write down the mechanical equations of magnetohydrodynamics. (7)
OR
c What are the consequences of Alfven's theorem? (7)
d Obtain the decomposition of the electromagnetic stresses. (8)
- 4 a For a force-free magnetic field, prove that $\mu\sigma\frac{\partial\mathbf{B}}{\partial t} = -\alpha^2\mathbf{B}$. (7)
b Give an example of force-free field for the case of non-constant α and the rectangular coordinates. (8)
OR
c Derive the equation of Alfven waves for an incompressible inviscid fluid. Also discuss about their propagation. (15)
- 5 a Discuss about stationary plane shock waves in the absence of a magnetic field. (10)
b Investigate the stability of a stationary state of any given system by the use of an energy principle. (5)
OR
c Explain the flute instability. (7)
d Find the solution of the displacement equation of the hydromagnetic problem of stability by the method of small oscillations. (8)

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END

