M.A./M.Sc. Examination 2018

Semester - III

Mathematics

Course: MMO-31 (A6) (New)

(Dynamical Meteorology)

Time: Three Hours | Full Marks: 40

Questions are of value as indicated in the margin.
Notations and symbols have their usual meanings.
Attempt ***any four*** questions.

1. a) Define potential temperature and obtain the relation $S = C_p l_n \theta + \text{constant}$, between the entropy S and potential temperature θ of a parcel of dry air. Show that potential temperature remains constant in an isentropic flow. 1+3+1

   b) For reversible saturated adiabatic changes of state in the atmosphere, show that

   $$\left(\frac{dT}{dp}\right)_{moist} < \left(\frac{dT}{dp}\right)_{dry}.$$ 5

2. a) What is Geostrophic approximation? Obtain the equations of the geostrophic wind motion, stating clearly the assumptions made. Show that the geostrophic wind velocity may be taken as the first approximation of the actual wind velocity. 1+4

   b) Obtain the adiabatic lapse rate of temperature with altitude. Discuss the stability of the atmospheric equilibrium. 5

3. a) Obtain the general equation of motion of the atmosphere relative to the rotating earth and hence deduce the Euler's equation of motion for a perfect fluid and Navier-Stokes equation for viscous fluid. 5

   b) Show that the rate of change of absolute circulation C round a closed curve Γ moving with the atmosphere is given by $\dot{C} = \iint_{\Sigma} grad\, T \times grad\, S \cdot \hat{n}\, d\Sigma$,

   where $\sum$ is an open surface, T and S are the absolute temperature and specific entropy, and $\hat{n}$ is the unit outward normal to $\sum$. 5

4. a) State the quasi-static hypotheses. Obtain the quasi-static equation of continuity for the atmosphere. 1+4

   b) Define the potential vorticity of the atmosphere. Obtain Ertel's formula for potential vorticity in an inviscid rotating fluid and establish the Rossby's theorem. 5

5. a) Write down the basic governing equations of motion for a dry parcel of air relative to rotating earth. Obtain the pressure tendency equation of the atmospheric motion in the following form:

   $\frac{\partial p}{\partial t} = g\rho\omega - g\int_z^{\infty} \nabla_h \cdot \left(\rho \vec{q}_h\right) dz$ and interpret the different terms involved in this equation. 1+3

   b) Derive Friedman's equation for the change of absolute vorticity. Point out the causes for changes in absolute vorticity. 5+1

P.T.O.

6. Write short notes on ***any two*** of the following: 5x2=10
   a) Trade wind and anti-trade wind
   b) Rossby waves
   c) Lee waves
   d) Nor-western wind flow

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