

**2023**  
**B.A./B.Sc.**  
**Sixth Semester**  
DISCIPLINE SPECIFIC ELECTIVE – 4  
**PHYSICS**  
*Course Code: PHD 6.21 (B)*  
(Atmospheric Physics)

*Total Mark: 70*  
*Time: 3 hours*

*Pass Mark: 28*

*Answer five questions, taking one from each unit.*

**UNIT-I**

1. (a) Discuss the composition of the atmosphere. 4  
(b) Derive the equation of state for a mixture in terms of its mean molar weight. 5  
(c) Derive the hydrostatic equation. 5
2. (a) What are cyclones and anticyclones? 4  
(b) What are thunderstorms? Explain the formation of thunderstorms. 2+5=7  
(c) A gas mixture of 300 L at 273 K and total pressure of 0.75 atm contains 6.7 mol of hydrogen gas and 3.3 mol of oxygen gas. What is the partial pressure of hydrogen gas? 3

**UNIT-II**

3. (a) What are fundamental forces? Derive an expression for the total pressure gradient force per unit mass. 1+5= 6  
(b) Discuss scale analysis with an illustration. 4  
(c) Write a short note on quasi biennial oscillation. 4
4. (a) Derive an expression for the vectorial form of the momentum equation in rotating coordinate system. 6  
(b) State and prove the Bjerknes's circulation theorem. 1+4=5

- (c) At the 300-hPa (around 10 km) level along  $40^\circ$  N during winter, the zonally averaged zonal wind [ $u$ ] is eastward at  $20 \text{ m s}^{-1}$  and the zonally averaged meridional wind component [ $v$ ] is southward at  $30 \text{ cm s}^{-1}$ . Estimate the vorticity and divergence averaged over the polar cap region poleward of  $40^\circ$  N. 3

### UNIT-III

5. (a) Discuss the propagation of atmospheric gravity waves in a non-homogeneous medium. 6  
(b) Derive an expression for the propagation of Rossby waves in three dimensions. 6  
(c) Explain briefly Lamb wave. 2
6. (a) Discuss the difference between deep-water wave and shallow water with respect to the depth of water and wavelength of the wave. 6  
(b) Write a short note on the following:  $4 \times 2 = 8$   
(i) Surface water waves  
(ii) Acoustic waves

### UNIT-IV

7. (a) Discuss the various types of atmospheric radar. 7  
(b) Describe the working of a radar. Derive the radar equation.  $3+4=7$
8. (a) Discuss the application of a lidar. Write four differences between radar and lidar.  $4+4=8$   
(b) Explain in detail the working and theory of a moving target indicator radar. 6

### UNIT-V

9. (a) Discuss the spectral distribution of the solar radiation. 5  
(b) Prove that Rayleigh scattering cross section of an air molecule is inversely proportional to the fourth power of the wavelength. 6  
(c) Write three properties of aerosols. 3
10. (a) Discuss the radiative effect and health effect of atmospheric aerosols on human. 4

- (b) If the rate of decrease in the number concentration  $N$  of a mono dispersed aerosol due to coagulation is given by  $-(dN/dt) = KN^2$ , where  $K = 1.40 \times 10^{-15} \text{ m}^3\text{s}^{-1}$  for 0.10 micro meter diameter particles at  $20^\circ\text{C}$  and 1 atm, determine the time required at  $20^\circ\text{C}$  and 1 atm for coagulation to decrease the concentration of a monodispersed atmospheric aerosol with particles of a diameter of 0.100 micro meter to one-half of its initial concentration of  $1.00 \times 10^{11} \text{ m}^{-3}$ . 4
- (c) State and prove the Bouguert-Lambert law. 1+5=6
-