INDIA METEOROLOGICAL DEPARTMENT

QUESTION BANK

OF

INTEGRATED MET. TRAINING COURSE (IMTC)

FINAL EXAMINATION

BASED ON 1-11 BATCHES (2013-2021)

PAPER-I: DYNAMIC METEOROLOGY AND NWP

PART A : DYNAMIC METEOROLOGY

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Q 1. Fill in the blanks

1. The purpose(s) of the hypso-metric equation is to determine _____.

2. Cold core low _____ with height.

3. If $\phi(x,y,z) = 3x^2y - y^3z^2$ then $\nabla\phi$ at the point (1, -2, -1) is _____.

4. In barotropic atmosphere isobaric and isothermal surfaces _____.

5. Pressure Gradient Force is _____ force.

6. Transport of any physical quantity by horizontal wind is called _____.

7. In baroclinic atmosphere density is the function of _____.

8. For pure deformation motion streamlines are family of _____.

9. Ageostrophic wind is proportional to _____.

10. --------------------- gradient wind is super Geostrophic.

11. Coriolis force is a _____ force.

12. For Geostrophic approximation to be valid, Rossby number should be _____.

13. Cyclonic gradient wind is _____.

14. Streamlines for pure divergence are _____

15. In a baroclinic atmosphere constant density lines cannot be _____ to isobars.

16. Downstream decrease of wind results in _____.

17. For a given north-south temperature gradient, meridional component of thermal wind is _____

18. The vector B = yz i + zx j + xy k is non _____.

19. In southern hemisphere around a trough isobars turn in _____ sense.

20. For a turbulent flow, Richardson Number should be _____.

21. Dine's Compensation Principle is a direct corollary to _____ .

22. Cyclostrophic flow is very _____ near the equator.

23. GPM is the unit of Specific _____.

24. Geostrophic flow is parallel to _____ .

25. Divergence is the measure of _____ .

26. For pure rotation streamlines are _____ .

27. Inertial flow is always _____.

28. Cyclones/ anticyclones form due to _____ of earth.

29. Geostrophic Approximation doesn't hold near _____.

30. In a Barotropic atmosphere, isobaric surfaces are _____ to isothermal surfaces.

31. Order of magnitude of inertial acceleration is _____ .

32. For pure rotational flow _____ & _____ don't change.

33. Frictional force is an example of _____ force.

34. For a laminar flow Richardson number should be _____.

35. Coriolis force is-------------- at pole

36. PBL contains ---- of atmosphere & is characterized by ------------- motion

37. In case of thunderstorm, PBL may extend upto-------------------

38. Stream lines and trajectories are same under_____ condition .

39. Cyclonic gradient wind is_____.

40. Divergene is the measure of _____.

41. _____is the Moisture continuity equation.

42. Equation for Hydrostatic equilibrium is _____.

43. Expression of Vorticity in Natural coordinate system is _____.

44. $d/dt = $ _____.

45. In barotropic atmosphere ---------------------------------------

a) pressure systems tilt with height b) isobaric and isothermal surfaces intersect c) there is a vertical wind shear d) none of the above

46. Thermal winds blow keeping cold to the _____in northern hemisphere.

47. Hydrostatic approximation is the balance between _____.

48. Thermal winds blows keeping cold to the _____ in northern hemisphere.

49. Example of body forces are _____ .

50. Hydrostatic approximation is valid if there is _____ (net vertical acceleration/ no net vertical acceleration)

51. Coriolis force is a _____ force doesn't exist in a _____frame.

52. Downstream increase of wind results in _____

Q. 2] State with brief reason whether following statements are True or False

1. Rosby number is measure of validity of Geostrophic approximation
2. Monsoon trough tilts towards south as height increases
3. Tibetan anticyclone intensifies with height.
4. Streamlines and trajectories are always same.
5. Inertial flow is always cyclonic
6. Backing is associated with warm air advection.
7. There is no thermal wind in barotrophic atmosphere
8. Cold core low intensifies with height.
9. Ageostrophic wind is solely responsible for atmospheric divergence.
10. Anticyclonic gradient wind is sub geostrophic.
11. Equatorial belt is favourable for cyclostrophic flow.
12. Divergence causes expansion.
13. A stabley stratified PBL is characterized by convective turbulence.
14. For a steady state flow trajectories are same as streamlines.
15. Level of non-divergence has nothing to do with day-to-day weather development.
16. Hydrostatic balance holds good in the wall cloud region of a tropical cyclone.
17. Anomalous flow is weaker than a regular flow.
18. Order of magnitude of vertical component of pressure gradient force is more than that of horizontal component.
19. Convective turbulence in PBL is due to wind shear.
20. Veering of geostrophic wind is associated with cold air advection.
21. A PBL with super adiabatic lapse rate is characterized with mechanical turbulence.
22. Rising motion results from convergence.
23. LND has nothing to do with daily weather forecasting
24. Dines compensation principle is a direct corollary to the law of conservation of energy.
25. Pressure (p) can be used as a vertical co-ordinate.
26. Rossby number is measure of validity of Hydrostatic approximation.
27. In barotropic atmosphere the pressure system tilts with height.
28. In northern hemisphere the direction of wind in tornadoes either cyclonic or anticyclonic
29. Vertical motion take place at the level of non-divergence.
30. Gravitation is the sum of gravity and centrifugal force.
31. In the equation of motions in isobaric coordinate, density does not occur explicitly.

32. Thermal wind blows keeping cold to the right in northern hemisphere.

33. In Ekman layer PGF and frictional force are comparable.

34. Coriolis force has much a greater effect farther away from the equator

35. Geostrophic balance is generally valid over Ocean or High above the ground.

36. There is no thermal wind in barotrophic atmosphere.

37. Gravity and gravitational force is same.

3] Answer the following questions

1. With a neat diagram schematically show how horizontal temperature gradient can lead to vertical shear of geostrophic wind. Hence or otherwise define thermal wind and write down its equation.

2. Discuss the properties of thermal wind and application of its concept.

3. Define natural co-ordinate. Write down horizontal equation of motion in natural co-ordinate. Define gradient flow and write down the equation for gradient flow.

4. Discuss different special cases of gradient balance.

5. Define streamline and trajectory. Write down equation for stream line and trajectory. Discuss under what condition they will be same.

6. Discuss stream line pattern for pure deformation and pure rotation.

7. With a neat diagram explain how geostrophic balance is achieved; hence or otherwise define geostrophic wind. Write the vector equation for geostrophic wind. Discuss properties of geostrophic wind.

8. What is continuity equation. Write down this equation in mass divergence form. Why the variable'P' is superior as vertical co-ordinate, than 'Z' ? Discuss how vertical velocity (Omega) can be found out using continuity equation in 'p' co-ordinate.

9. Define PBL. Mention different sub-layers in PBL with dominant forces. What is the importance of PBL ? Discuss the characteristic features of PBL.

10. Define scale of atmospheric motion and scale analysis. Mention the steps to be followed for performing scale analysis on a governing equation.

11. Define geostrophic flow. Write down the vector equation for geostrophic flow. Discuss properties of geostrophic flow.

12. Define geopotential and geopetental height. Write down Hygrometric equation. Hence or otherwise discuss how height of isobaric levels are determined at a station from RS ascent.

13. Define natural co-ordinate. Write down horizontal momentum equation in natural co-ordinate. Hence or otherwise define and write down the gradient wind equation. Using expression of divergence and vorticity in natural co-ordinate, discuss the role of wind sheer leading to divergent and vorticity.

14. Distinguish between gravity and gravitation. Hence or otherwise discuss why earth has an oblate spheroid shape. Discuss how hydrostatic approximation is obtained. Discuss the usefulness of this approximation.

15. Define streamline and trajectory. Write down equation for streamline and trajectory. Discuss the relation between them. Discuss stream line pattern for pure deformation.

16. Define Low, High, Trough, Ridge & Col and also give their mathematical conditions & diagram

17. Define streamline and trajectory. Write down the equation of streamline and trajectory. Write down the streamline pattern for pure stretching deformation and also state the change of Shape, Orientation, Area and Position of the wind field.

18. Explain how horizontal temperature gradient can lead to vertical shear of geostrophic wind. Define thermal wind. Write down the thermal wind equation and state the properties of thermal wind. Explain how cold core low intensifies with height from the thermal wind concept.

19. Define natural co-ordinate. Write down horizontal momentum equation in natural co-ordinate. Hence or otherwise define and write down the gradient wind equation. Discuss different special cases of gradient balance.

20. Write down the definition and equation of thermal wind. Discuss the properties of thermal wind and application of its concept.

21. Define natural co-ordinate. Write down horizontal equation of motion in natural co-ordinate. Define gradient flow and write down the equation for gradient flow

22. Discuss in detail all feasible gradient flow.

23. Define geopotential and geopotential height. Write down Hypsometric equation. Hence or otherwise discuss how height of isobaric levels are determined at a station from RS ascent.

24. Write down vector equation of thermal wind.

25. Write down horizontal equation of motion in natural co-ordinate

26. Write down the expression for velocity vector of an intense low-pressure area with circular symmetry.

27. Write down the expression for vorticity in natural coordinate.

28. Write down differential equations for stream line and trajectory.

29. Name different sub layers in Planetary boundary layer

30. Write down different components of Coriolis force at a latitude

31. Explain with equation Divergence in cartesian coordinates

32. Explain with equation Vorticity in cartesian coordinates

33. Write down the importance of Hydrostatic balance.

34. Write down the use of Hydrostatic balance.

35. Discuss possible gradient flow in the following cases.

      a. Case-1: R positive and $\frac{\partial P}{\partial n}$ negative, the symbols have their usual meaning

      b. Case-2: R negative and $\frac{\partial P}{\partial n}$ negative, the symbols have their usual meaning

36. What is continuity equation.

37. Write down this equation in mass divergence form.

38. Discuss geostrophic wind and its properties.

39. With the help of mathematical condition and diagram define Low, High, Trough and Ridge

40. Define thermal wind with equation.

41. Discuss the properties of thermal wind.

42. Explain Mass continuity equation.

43. Explain Dines compensation principle and its application?

4] Write shorts notes on
1. Planetary boundary layer
2. Ageostophic Wind
3. Hypsometric equation.
4. Thermal wind
5. Inertial flow
6. Hydrostatic balance (importance & use)
7. Stream line and trajectory.
8. Dines compensation principle.
9. Geostrophic flow.
10. Inertial and Non-Inertial Frame
11. Divergence and Vorticity
12. Backing and Veering of wind
13. Gravity and gravitation
14. Vorticity in natural coordinate
15. Natural coordinate system.
16. Equation of motion in natural coordinate
17. Veering and Backing of wind.
18. With the help of mathematical condition and diagram define Ridge
19. With the help of mathematical condition and diagram define Col
20. Using expression of divergence and vorticity in natural co-ordinate, discuss the role of wind sheer leading to divergent and vorticity
21. Mention different sub-layers in PBL with dominant forces
22. Why the variable P' is superior as vertical co-ordinate, than 'Z' ?
23. Define scale analysis.
24. Discuss stream line pattern for pure deformation.
25. Discuss stream line pattern for pure rotation.