INDIA METEOROLOGICAL DEPARTMENT

QUESTION BANK

OF

FORECASTERS TRAINING COURSE (FTC)

FINAL EXAMINATION

BASED ON 176-191 BATCHES

(2013-2021)

PAPER-I: NUMERICAL WEATHER PREDICTION

PART B

India Meteorological Department

Office of Climate Research & Services

Meteorological Training Institute

Forecasters Training Course

Final Examination

Paper-I : NUMERICAL WEATHER PREDICTION (PART-B)

Q.1 Fill in the blanks

1. _____ Scheme is a convective adjustment scheme.
2. _____
3. According to CFL criteria distance travelled in one time step is-----grid length, for stable numerical solution.
4. Advection of warm anomaly at 500 mb over a surface LOPAR is an indication of----------of the surface system.
5. Agriculture sector demands weather forecasts in time scales of a _____.
6. Arakawa Schubert in his convective scheme used entrainment at _____ and detrainment at_____.
7. Aviation sector demands _____weather forecasts
8. Aviation sector demands weather forecasts in time scales of a _____.
9. Bowen ratio is _____ in rain forest area than semi arid region.
10. Bowen ratio over semi-arid region is _____ than over irrigated land.
11. By parameterization the effect of sulgrid scale processes are used in _____.
12. Convective clouds transport _____ to _____.
13. _____downscaling models can be developed off line.
14. Elimination of spurious gravity wave from gridded analysed data is done by _____.
15. Example of a boundary value problem is _____.
16. Failure of Richardson was mainly due to----------
17. False Alarm rate is the ratio of ---------to----------.
18. For computation of pressure tendency _____ scheme is used.
19. For computing lapse rate at surface _____ difference scheme is suitable.
20. For computing pressure tendency _____ difference scheme is suitable.
21. For linear computation stability, $C\Delta t / \Delta x$ _____.

22. For T574L64 global model, the horizontal resolution is _____ km.
23. Forecast model must not have been changed during._____ and _____ period of statistical downscaling.
24. General effect of mountain blocking is to _____ the air motion.
25. Governing equations are---------- Partial differential equations.
26. Hydrostatic balance eliminates _____ wave.
27. In _____ scheme ensemble of clouds of various size has been considered
28. In Arakawa and Schubert scheme entrainment is considered in _____ level but detrainment in _____ level.
29. In best categorical forecast skill Hit rate is----------.
30. In Cressman method error in the guess is corrected using _____.
31. In NWP, predictions are made by solving the _____ equations.
32. In spectral method horizontal variation of meteorological variable is expressed by _____.
33. In the history of NWP, the first successful operational NWP model was developed by _____, _____, and _____.
34. Initialization eliminates _____ wave.
35. Initialization is required to bring _____ between observed and model state in the initial data.
36. Kuo assumed total rate of moisture accession as the sum of _____, _____ and _____.
37. Kuo's scheme is not useful for _____ resolution.
38. Large _____ and small _____ environment may lead to formation of thunderstorms in isolated regions of very heavy rain. [CINE/CAPE]
39. Manabe's scheme is a _____ scheme.
40. Non linear equations are very sensitive to----------conditions.
41. NWP can give _____ & _____ specific weather forecast.
42. NWP models are generally of two types, viz., _____ & _____ etc.
43. Objective analysis is for preparation of _____ from observed data.
44. Operational Global Deterministic Model in IMD is _____. [GFS/WRF]
45. Precipitable water content and moisture flux convergence are useful in _____ precipitation forecasts. [quantitative/ qualitative]
46. Principal Component Analysis for statistical downscaling is used when there is significant _____ between the predicators.

47. Problem of forecasting weather at a place is essentially_____
48. Repeated aliasing may cause _____.
49. Subgrid scale processes are _____ so that their effect can be considered in _____ scale model.
50. Subgrid scale processes cannot be dealt with _____ in a model, their effect in macroscale is _____.
51. The basic equation of physics used in NWP models are known as _____ (Advanced/primitive) equations
52. The climate scenario over a station from GCM output can be found using----------.
53. The horizontal resolution of GFS (T1534L64) is approximately _____Km. [12/18]
54. The major effects of cloud on large scale environment are transfer of _____, _____ and _____.
55. The rate of precipitation is _____ related to moisture flux divergence. [directly/indirectly]
56. Three main layers in any neural network are _____, _____ and _____.
57. To compute lapse rate at surface/mean sea level, _____ scheme should be used.
58. To downscale to a station level forecast _____ downscaling can be used.
59. To find out lapse rate at surface----------scheme should be used.
60. To fit a cubic polynomial at least _____ observations are required.
61. To preserve height of a terrain in GCM model _____ orography is used.
62. Two main types of downscaling are _____ and _____.
63. Weather at any time and place is a function of _____
64. Weather forecasting basically consists of ____ steps.
65. Weather forecasting basically is an ---------- problem.

Q.2 State with brief reason whether following statements are true or false

1. Kuo assumed large scale moisture convergence and conditionally unstable atmosphere. Kuo assumed that (i) atmosphere should be conditionally unstable and (ii) presence of large scale moisture convergence.
2. Aliasing errors can be eliminated in spectral method.
3. Arakawa Schubert scheme is an instability control scheme.

4. Arakawa Schubert's scheme can be categorized as mass flux scheme.
5. As a vertical co-ordinate σ is more suitable than p (pressure).
6. Attempt of L.F. Richardson to predict pressure tendency first time was successful.
7. Baroclinic models do not allow temperature advection.
8. Best possible skill in Brier score is one.
9. Central difference scheme is suitable for computation of tendency at the initial time.
10. Cloudiness has a large influence on solar radiation.
11. Familiarity with the NWP model's strengths and weaknesses on the forecaster's part is not essential.
12. First operationally successful NWP model was to predict temperature.
13. For numerically computing the lapse rate at surface, backward difference scheme should be used.
14. Forward difference scheme is an implicit scheme.
15. From the expression of work function in Arakawa Schubert scheme it can be shown that more the entrainment shallower is the cloud.
16. Governing equations can be solved analytical.
17. Grid data is prepared using initialization.
18. Gridded data is prepared using objective analysis.
19. Hydrostatic version of a model should be applied for the wall cloud region of a tropical cyclone
20. In Arakawa Schubert Scheme more the entrainment shallower will be the cloud depth.
21. In Arakawa Schubert Scheme, larger value of entrainment rate leads to shallower cloud.
22. In static initialization the model is being run during a pre-forecast period.
23. In static initialization, the model runs forward and backward, to bring balance between observed and model state of the atmosphere.
24. Initialization is required to eliminate spurious gravity waves.
25. Kuo assumed atmosphere to be conditionally unstable and there in large scale moisture convergence.
26. Kuo scheme is used for Radiation parameterization.
27. Leap frog scheme is unconditionally stable.
28. Manabe's scheme is a convective adjustment scheme.
29. Mention different important model output derived products. Discuss the interpretation and application of any two of them.

30. Model analysis are usually generated by blending a first-guess field with an observational data set.
31. Models which use the entire vertical momentum equation are known as non-hydrostatic model.
32. Monsoon Mission coupled Forecasting system uses a grid point model for the atmosphere and a spectral model for the ocean.
33. NWP can give location and time specific forecast.
34. NWP can't give objective forecasting.
35. NWP can't give time and location specific forecast.
36. Objectively analyzed data can directly be ingested into NWP model, without initialization.
37. Objectively analyzed data can't directly be ingested into NWP model, without initialization.
38. Perfect forecast is possible. Post-processing translates model output from the model's native format into meaningful standardized output.
39. RADAR data are assimilated in nowcast/short range forecast.
40. Spectral method is free from linear computational instability.
41. Spherical harmonics are generally used in Grid point method.
42. Subgrid scale processes are parameterized.
43. Synoptic method of forecasting can give location & time specific forecast.
44. The blending of the background fields and the observations are done in the objective analysis process of NWP Models.
45. To compute lapse rate at surface, backward difference scheme may be used.
46. Weather forecasting is an Initial value problem only.
47. WRF model don't require any input from global model.
48. Threat score of following thunderstorm forecast (given in 2x2 contingency table).

		Thunderstorm observed	
Thunderstorm forecast		YES	NO
	YES	20	80

NO	30	270

is 0.15

a) Probability of detection for above problem is 0.4

b) False Alarm Rate for the problem in above, is 0.8.

Q.3 Answer the following questions

1. Components of operational NWP models.
2. Define an initial value problem. When an initial value problem is said to be ill posed and well posed?
3. Define data assimilation. Discuss in brief about variational data assimilation technique?
4. Define the major steps in NWP forecast process and explain any one of them.
5. Discuss briefly about "**Triangular Truncation in wave-number (m, n) space**", with suitable diagram and examples.
6. Discuss in brief about different components of a NWP model, in general.
7. Discuss in brief about the basic concepts of objective analysis and initialization.
8. Discuss in brief about the Cressman scheme for objective analysis.
9. Discuss in brief about the ensemble prediction system.
10. Discuss in brief about the univariate optimum interpolation scheme for objective analysis.
11. Discuss in brief hierarchy of forecasting models in NWP.
12. Discuss in brief the importance of objective analysis and initialization
13. Discuss in brief, using a block diagram, different components and their functions of an NWP system.
14. Explain Kuo's convective parameterization scheme.
15. Express Laplaces differential equation in finite difference form and explain how to solve numerically.
16. Hydrostatic models.
17. Mention 5 different important derived NWP products. Explain interpretation and application of any three of them.
18. Mention about three finite difference schemes. Discuss in brief about them. What is CFL criteria for linear computational stability?

19. Mention any five derived products of NWP. Write down the working formula, corresponding numerical approximation for thermal advection and vorticity advection and discuss how they can be used as NWP guidance in forecasting.
20. Mention different finite difference schemes. Discuss what finite difference scheme is used to find pressure tendency at a point and why? Write down CFL condition and explain its physical interpretation.
21. Name four processes which need to be parameterized. (2 marks)
22. Post processing models.
23. What are different types of vertical coordinates used in WRF (ARW and NMM) model? Describe different kinds of staggering used in WRF(ARW) and WRF(NMM) versions of the model with schematic diagrams.
24. What are the Aviation forecast products available from WRF model and also forecast products provided by INCOIS in real-time.
25. What are the conventional and non-conventional data used in NWP models and explain any two quality control procedures followed in GFS.
26. What do you mean by Spectral method ? In which part of the Climate Forecast System (CFS version-2), Spectral method is utilized? Briefly explain how non-linear computational Instability (Aliasing) can be tackled by spectral method.
27. What is full form of WRF? WRF model is used for what kind of weathers and for that what are various characteristics differences from the global model GFS used in IMD?
28. What is parameterization? (1 mark)
29. What is sub grid scale parameterization? Mention different important such processes. Discuss in brief on parameterization of any one of these processes.
30. Why numerical method is important in NWP. Mention about three finite difference schemes. Discuss in brief about them.
31. Why to parameterize physical processes? (2 marks)
32. Write a brief note on finite difference method.

Q.4 Write short notes

1. Kuo’s convective parameterization scheme.
2. Land surface process parameterization.
3. Forecast Verification.
4. Ensemble forecasts.

5. What are the major steps in forecast process. Discuss any two process.
6. What is the advantage of non-hydrostatic models.
7. Why forecast verification is done and what are the quantitative verification process used in NWP models. Explain any two methods.
8. Kuo’s cumulus parameterization scheme.
9. Fluxes associated with surface energy budget.
10. Convective adjustment scheme by Manabe
11. Statistical downscaling
12. Bias correction by quintile mapping.