Nepal Engineering Council Registration Examination

Meteorology Engineering Syllabus (AMeE)

Chapters 1-4 are fundamentals/principles of concepts in meteorology; chapters 5-9 are related to application of meteorology principles in practice; and the last (10th) chapter is related to project planning, design and implementation.

1. Basics of Meteorology (AMeE01)

1.1 Science of Meteorology: Definition and Importance of Meteorology, various branches of Meteorology and their applications, Relation of Meteorology to other Sciences. (AMeE0101)

1.2 Meteorological Data Collection: Department of Hydrology and Meteorology, It's mandate and organizational structure, Required Data and Instruments. (AMeE0102)

1.3 International Organizations related to Meteorology: WMO, ICAO and Global Climate Observation System. (AMeE0103)

1.4 Meteorological Factors: Earth-Sun relationship, Ecliptic and equatorial plane, Rotation and revolution of the earth equinoxes, Solstices, Perihelion and Aphelion, Seasons and their causes. (AMeE0104)

1.5 Weather System: Weather, climate, Elements of weather, climate controls, weather phenomena, Semi-diurnal variation of pressure, Diurnal variation of temperature. (AMeE0105)

1.6 Pressure and Temperature: General circulation of the atmosphere over the globe; Pressure and wind belts; Distribution of pressure and temperature over the surface of the earth; Equatorial trough & Inter tropical convergence zone. (AMeE0106)

2. METEOROLOGICAL PARAMETERS AND MEASUREMENTS (AMeE02)

2.1 Solar Radiation, Sunshine and Evaporation: Radiometer, Sunshine recorder and Evaporimeters (Types, working, reading and units) (AMeE0201)

2.2 Atmospheric pressure: Barometer (Fortin and Kew Pattern, description, reading, correction, reducing the value to mean sea level, exposure); Aneroid/precision barometer. (AMeE0202)

2.3 Temperature, Humidity and Wind: Thermometers (Dry Bulb, Wet Bulb, Maximum and Minimum; description, method of working, reading and resetting), Stevenson screen and Psychrometers, exposure, care of instruments, Relative Humidity, Dew point temperature; Wind vane and Anemometer (description and working, units) (AMeE0203)

2.4 Clouds, Rain and Snow: Classification, amount, height of base and direction of movement of clouds; Visibility: Definition, visibility land marks, night visibility; various weather phenomena, special weather reporting, symbolic representation of weather; Rain and Snow Gauges (Types, working and measurement of rain and snow). (AMeE0204)

2.5 Recording of surface observations: Pocket register; monthly meteorological register, weather diary. (AMeE0205)

2.6 Self recording instruments: Description and working of barograph, thermograph, hygrograph, self recording rain gauge, Dines PT anemograph, and Sunshine recorder; Tabulation and analysis of barograph, anemograph and thermographs; ARG, AWS, Aviation-met and Agro-met instruments. (AMeE0206)

3. DYNAMIC METEOROLOGY (AMeE03)

3.1 Equation of Motion: Frames of reference, Vector equation of motion in inertial & non-inertial frame; Local tangential coordinate system; Equation of motion and explanation; Horizontal equation of motion with pressure as a vertical co-ordinate; Atmospheric forces; Real & apparent forces, body & surface forces, Coriolis force, Pressure gradient force, Centrifugal force, Gravity force. (AMeE0301)

3.2 **Geostrophic and Hydrostatic Approximation:** Scale analysis for the mid-latitude large-scale weather systems; Rossby number; hydrostatic and geostrophic balance; inertial flow; cyclostrophic flow; gradient flow and the gradient-wind balance for a steady circular vortex; Vertical variation and shear of the geostrophic wind; thermal wind; pressure co-ordinates and geo-potential height; Hypsometric equation and its use in computing thickness of atmospheric layers. (AMeE0302)

3.3 **Kinematics of wind and pressure field:** Definition of Streamlines and trajectory, relation between them; streamline patterns for pure translations, pure divergence, pure rotations and deformations; Definition and mathematical expression for center of Lows/ highs, equation for trough/ ridge and Col. (AMeE0303)

3.4 **Conservation of mass:** Equation of continuity; Dines compensation principle; Concept of the level of non- divergence; Moisture continuity equation. (AMeE0304)

3.5 **Divergence & vorticity:** Definition & their mathematical expression; Illustration by typical cases on synoptic charts; PBL and its Importance, Convective turbulence & mechanical turbulence, depth of PBL, Static stability, Richardson number, Different sub layers in PBL.. (AMeE0305)

3.6 **Numerical weather prediction:** Finite differences and truncation errors; Numerical solution of Laplace, Poisson and Helmholtz equations by iterative methods; relaxation techniques; spectral methods; Primitive equation models; model variables; inclusion of moisture and radiation effects; optimum interpolation method; Current operational models; co-ordinate systems and numerical formulation; Application of model products to the prediction of routine parameters and specific events. (AMeE0306)

4. CLIMATOLOGY AND SYNOPTIC METEOROLOGY (AMeE04)

4.1 Climatic elements and data: Temperature, precipitation, humidity, wind speed, visibility, sky cover, sunshine, radiation and their space-time variability; Climatic controls viz. natural influences, latitude, relief, water, ice and snow; anthropogenic effects; Collection, processing, storage and retrieval of climatological data; quality assurance and quality control of data; Internal, temporal and spatial consistency checks; monthly record of extreme values; Use of specific weather analysis software; Preparation and dissemination of routine climatological information. (AMeE0401)

4.2 Climatic measurements: Instruments and methods of observation for the climatic elements; Installation of climatological stations and shelter; Principal and ordinary stations; Precipitation stations and stations for specific purposes; Pluviographs; soil temperature; soil moisture; humidity; Psychrometers, hygro-thermographs; Dew point measurement; Sunshine and solar radiation; sunshine recorder; actinographs. (AMeE0402)

4.3 Climate and seasons of Nepal: East West variation, orographic variation, western disturbances, Convection in pre and post monsoon, summer monsoon; Winter season - Western disturbance and Easterly waves and weather associated with them, fog and cold wave; Pre-monsoon season - Heat wave, cyclonic storms in the Indian seas; Monsoon season - onset and advance of southwest monsoon, semi permanent systems of monsoon, strong and weak monsoon, factors affecting distribution of monsoon, synoptic systems in monsoon; Post monsoon season; Withdrawal of southwest monsoon and northeast monsoon. (AMeE0403)

4.4 Climate change and Global warming: Basics of climate change; observed climate change over Nepal and globe; Global warming, its causes and impact on environment; Green House Gases (GHGs), anthropogenic change of climate, Impact of climate change in Nepal; Thunderstorm and synoptic conditions favorable for thunderstorm, concepts of triggering mechanism; Dust storm, hail storm, squall, tornado, microburst/cloudburst, landslide. (AMeE0404)

4.5 Synoptic analysis: Displaying and analyzing surface pressure and upper-air charts to identify centers of high and low pressure, frontal boundaries, weather patterns; operational NWP output; Satellite and radar imagery; Monitoring the receipt of operational forecasts and warnings from the main centre; Communicating forecasts and warnings to the public, authorities and individual customers. (AMeE0405)

4.6 Weather forecasting: Basic principles of weather forecasting; application of wave cyclone model and other conceptual models; Forecasting methods; persistence, extrapolation and analogue schemes; numerical weather prediction scheme; Post-processing and interpretation of numerical model outputs; Stochastic models; Monte Carlo methods; Public weather services; dissemination of general and local weather forecasts; Special services to aviation, agriculture, water sector, shipping, industry, commerce. (AMeE0406)

5. AGRICULTURAL METEOROLOGY (AMeE05)

5.1 Plant physiology: Plants and crop microclimate; core of plant interaction with the atmospheric environment; Photosynthesis, respiration and transpiration; Diurnal cycle; Photochemical processes in the light reactions; impact of low temperatures or low concentrations of CO_2 on the rate of dark reaction; Reduction of the total photosynthesis by low light intensities; Light saturation; Transpiration: driving force for liquid flow through the plant and water vapor flow between plant and the bulk air; equation for the transpiration rate; Soil-plant relations, soil nutrient reservoir; water reservoir; heat reservoir; source of oxygen-containing air for root respiration; Effects of physical and chemical environment and of meteorological factors on the growth and development of plants. (AMeE0501)

5.2 Bio-meteorological interrelationships: Plant pathology; Weather factors conducive to infection of plants and farm animals; Diseases and pests of crops and animals; Soil cultivation and treatment; crop management and layout; farm buildings, equipment and operations; Effect of climatic factors on the plant's growth rate; Effects of weather and climate extremes on physiological processes in vegetation; Effects of atmospheric factors on livestock production; Animal protection in an unfavorable climate; Effect of climate on population size, diseases, evaluation methods and techniques; Meteorological factors influencing the aerial movement and dispersal of spore, pollen, insects, birds, and other air-biota. (AMeE0502)

5.3 Surface energy balance: Basic concepts in planetary boundary layer; air temperature, heat exchange at the Earth's surface; soil temperature, transmission of heat in soil, heat budget; soil freezing, and the role of snow cover; Humidity and wind relations near the ground surface; the effect of surface conditions on boundary layer; annual variations of soil temperature and moisture; influence of plant cover in micrometeorology; importance of the air layer near the ground for agriculture; Artificial control of plants environment; energy budget; controlling the heat load - heat trapping and shading; protection from cold - supplementary heat and reduction in sensible and latent heat flux; controlling the soil heat budget. (AMeE0503)

5.4 Water balance: Determination of water loss from land surfaces; evaporation - fundamental processes, methods to determine evaporation and estimation of its energy balance; Penman, Priestley-Taylor and Penman-Monteith methods; Soil-moisture content and potential, moisture-energy relations, movement of water in the soil, influence of soil-moisture content and potential on plant growth; Estimation of local soil water budget and catchment yields from climatic data; controlling the soil moisture; efficiency of water use by various irrigation techniques. (AMeE0504)

5.5 Observations and measurements: Weather data networks and requirements; in situ and remote observations; instruments and methods of observation; quality assurance and quality control; Air temperature, grass-minimum temperature, surface temperature, soil temperature and soil heat flux, wind, radiation, sunshine hours, humidity, dew and leaf wetness; evaporation and evapo-transpiration, state of the ground and soil moisture; State of a crop and of the flow processes within and around the plants; Vegetation surveillance by remote sensing. (AMeE0505)

5.6 Data processing: Statistical and mathematical methods of data processing; procedures for evaluating and presenting the results; statistics of biological observations. (AMeE0506)

6. AERONAUTICAL METEOROLOGY (AMeE06)

6.1 Observing techniques: Surface wind direction and speed, including changes and variations; Visibility and runway visual range, including spatial and temporal variations in RVR observations, by visual means or by use of automatic instruments such as the transmissometer and forward-scatter meter; Cloud amount, height and type and spatial and temporal variations; Vertical visibility, observations using automatic instruments such as a ceilometers; Pressure measurements for the purpose of determining QFE and QNH. (AMeE0601)

6.2 Hazardous phenomena: Aircraft icing and its type; formation, accretion rates and association of icing with clouds; freezing precipitation, orographic and frontal lifting; Turbulence near

the ground as related to topography, air-mass stability, clouds, fronts and thunderstorms; High-level turbulence (CAT) and its association with jet streams; Wind shear; Volcanic ash. (AMeE0602)

6.3 F light planning: Meteorological basis for pressure-pattern flying; meteorological requirements for en-route winds and temperatures; weather and aerodrome forecasts; Interpretation of area, route and terminal forecasts and preparation of material for briefing of flight crews. (AMeE0603)

6.4 Reporting, coding and dissemination of weather information: International meteorological codes related to observations (METAR, SPECI, SYNOP, PILOT, TEMP) and aeronautical forecasts (TAF, ROFOR); Procedures for dissemination of weather information at the aerodrome, including the special needs of ATC units; Knowledge of the procedures for the preparation of the plain language forms of meteorological messages. (AMeE0604)

6.5 Procedures for meteorological services for international aviation: Organization of the meteorological service and particularly the functions of the various types of meteorological offices; Aeronautical meteorological stations and their functions, local routine and special observations and reports, reports in METAR and SPECI code forms; Meteorological watch; Observations required from aircraft and the procedures related to the ground-to-ground dissemination of these observations; Responsibilities of ICAO and WMO in aeronautical meteorology. (AMeE0605)

6.6 Aeronautical telecommunications: Organization of aeronautical telecommunications; operation of the aeronautical fixed service (particularly AFTN and ATN) and any special broadcasts and/or regional telecommunications networks applicable to the region concerned; message headings, addressing of messages, priorities of messages and any appropriate regional procedures; ICAO abbreviations used in messages on the aeronautical fixed services (AFS). (AMeE0606)

7. HYDRO-METEOROLOGY (AMeE07)

7.1 **Hydrological cycle and water balance:** Hydro-meteorological processes in land surface and atmosphere; Radiation, evaporation, condensation and precipitation processes; atmospheric boundary layer dynamics; coupled balance of moisture and energy; monsoonal flow and thunderstorms; Coupled models for the hydrological cycle; hydro-meteorological hazards. (AMeE0701)

7.2 **Surface hydrology:** Precipitation, evaporation, transpiration, infiltration, overland flow and channel flow; Numerical modeling of the rainfall-runoff process; Measurement River discharge; Records of daily, monthly, seasonal and annual flows, Use of hydrograph, Extreme discharges (floods and draughts), PMP and PMF; Flood forecasting and warning systems. (AMeE0702)

7.3 **Snow and ice hydrology:** Basic processes; Formation of snow and its effects on the atmosphere, Characteristics of snow cover; Formation of ice, Glaciers, Sea ice, Permafrost; Physics of melting and water movement through snow, Water equivalent of snow, Modeling snowmelt and stream flow, Snow avalanches, Worldwide distribution and extremes of snow cover, Estimates of catchment snowmelt inflow rates, Glacial Lake Outburst Flood. (AMeE0703)

7.4 **Flow measurements:** Stream gauging; Measuring stream discharge (surface and subsurface floats, current meters and velocity area method, automated moving boat method); Observation and recording of water levels; Preparation of stage-discharge curve; Estimation of flows. (AMeE0704)

7.5 **Ground water hydrology:** Ground water occurrence; Types of aquifers; Aquifer parameters; Darcy's law; Coefficient of permeability; Types of wells; Well construction and development. (AMeE0705)

7.6 **Hydrometeorology in the Urban Environment:** Urban boundary layer and the water cycle; Urban development and rainfall, Sewer flooding, Surface runoff from urban areas; Flood plain development, Acid rain, Urban air and water pollution; Urban floods, urban water logging and drainage problems. (AMeE0706)

8. RADAR AND SATELLITE METEOROLOGY (AMeE08)

8.1 **Basics of Radars:** Weather radars, Different frequency bands used in the weather radars and their applications, Principles of pulsed radar, Polarimetric radar, Doppler weather radar. (AMeE0801)

8.2 **Waves:** Attenuation of EM Waves v/s wave length; Scattering of EM waves (Rayleigh & Mie); Bending of radar beam with refraction (Sub & Super refraction); Effect of curvature of the Earth on the range of radar, Beam width, Pulse width, PRF, Antenna gain, back scattering cross section, Reflectivity factor (η) and radar reflectivity factor (Z). (AMeE0802)

8.3 **Doppler Weather Radar:** Block diagram of DWR and its major components; Magnetron, Klystron, waveguides and Ferrite Circulator; DWR base products Z, V and W; Doppler Dilemma and its interpretation – Range and velocity ambiguities; Operation procedure of DWR (volume scans, scheduler mode of operation and product generation– on line and offline); Radar calibration, validation and data dissemination. (AMeE0803)

8.4 **Warning products:** Sever weather index, Analysis of severe weather events (thunderstorms, hailstorms, heavy rainfall, aviation safety and tropical cyclones) recorded by DWR; Development of the now casting technique for their prediction. (AMeE0804)

8.5 **Basics of Satellite Meteorology:** Principles of Remote sensing and satellite meteorology, orbital mechanics, Meteorological satellites, Satellite data reception and processing, Ground based GPS system; Satellite Images. (AMeE0805)

8.6 **Interpretation of Satellite Images:** Characteristics of various channels; Identification of typical clouds and weather systems from cloud imageries; use of various satellite-derived products, Satellite bulletin and its interpretation; Tropical cyclones, their identification and grading using Dvorak's technique; Application of satellite data/products in Agro-meteorology and Aviation; Interpretation of microwave channel images. (AMeE0806)

9. STATISTICS AND PROBABILITY IN METEOROLOGY (AMeE09)

9.1 **Data and frequency distribution:** Statistical data of meteorology; Continuous and discontinuous variables, frequency distribution, frequency functions, diagrammatic representation, histograms, frequency curves. (AMeE0901)

9.2 **Measures of tendency and variation:** Requisites of good average; computation of arithmetic mean, median & mode; graphical determination of median and mode, merits and demerits of each, use of averages in meteorology; various measures, range, quartile-mean-standard deviations, co-efficient of variation and its use in meteorology, skewness, kurtosis. (AMeE0902)

9.3 **Correlation and Regression analysis:** Scatter diagram, Pearson's co-efficient of correlation, correlation analysis in meteorology, non-linear relation, regression lines of x on y and y on x, standard error of estimate, forecasting based on regression equation; Multiple regression equation with two independent variables, extension to more variables, partial correlation co-efficient, multiple correlation co-efficient, application in forecasting of met variables. (AMeE0903)

9.4 **Probability distributions and sampling:** Definition of probability, additive and multiplicative laws, Binomial, Poisson and Normal distributions, their applications in meteorology; Concept of sampling, random sampling, level of significance, standard error, testing of significance of sample mean and testing of significance of difference between two sample means, Student's t-distribution, testing the significance of correlation co-efficient. (AMeE0904)

9.5 **Time series analysis:** Definition of a time series, examples (meteorological), components of a time series (trend, seasonal and random variations), auto correlation co-efficient and its statistical significance, correlogram, random time series, stationary time series, Markov series. (AMeE0905)

9.6 **Harmonic and spectral analysis:** Definition of both, objectives, periodogram of a time series, computation of power spectrum, statistical significance, filters, effective length of a stationery time series. (AMeE0906)

10. Project Planning, Design and Implementation (AALL10)

10.1 Engineering drawings and its concepts: Fundamentals of standard drawing sheets, dimensions, scale, line diagram, orthographic projection, isometric projection/view, pictorial views, and sectional drawing. (AALL1001)

10.2 Engineering Economics: understanding of project cash flow; discount rate, interest and time value of money; basic methodologies for engineering economics analysis (Discounted Payback Period, NPV, IRR & MARR); comparison of alternatives, depreciation system and taxation system in Nepal. (AALL1002)

10.3 Project planning and scheduling: project classifications; project life cycle phases; project planning process; project scheduling (bar chart, CPM, PERT); resources levelling and smoothing; monitoring/evaluation/controlling. (AALL1003)

10.4 Project management: Information system; project risk analysis and management; project financing, tender and its process, and contract management. (AALL1004)

10.5 Engineering professional practice: Environment and society; professional ethics; regulatory environment; contemporary issues/problems in engineering; occupational health and safety; roles/responsibilities of Nepal Engineers Association (NEA). (AALL1005)

10.6 Engineering Regulatory Body: Nepal Engineering Council (Acts & Regulations). (AALL1006)

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