

नेपाल सरकार

शिक्षक सेवा आयोग

खुला प्रतियोगितात्मक लिखित परीक्षाको पाठ्यक्रम

२०७३

तह : निम्न माध्यमिक

विषय : गणित तथा विज्ञान

**Section B: Curriculum, Pedagogy and Technology in Mathematics & Science Teaching in Lower Secondary Level - 40 Marks**

**1 Study of Mathematics and Science & Environment Curriculum in Lower Secondary Level**

- 1.1 National curriculum framework 2063
- 1.2 Analysis of national goal, level-wise goal, grade-wise objectives and general objectives of mathematics and science & environment
- 1.3 Scope and sequence chart of primary and lower secondary mathematics and science & environment curriculum
- 1.4 Relevance of lower secondary school mathematics and science & environment curriculum to the changing needs and reality of society.
- 1.5 Curriculum development and criteria of good mathematics and science curriculum
- 1.6 Development of mathematics and science curriculum in Nepal

**2 Textbook, Teacher's Guide and Reference Materials**

- 2.1 Interrelationship between curriculum and textbook
- 2.2 Appraisal of curriculum, textbook and teacher's guide
- 2.3 Use of textbook and teaching without a textbook
- 2.4 Teacher's guide : Introduction, use and importance, present status of using the teacher's guide and making its use more effective
- 2.5 Reference and self-learning materials : Introduction, use and importance, present status of using the reference materials and making its use more effective

**3 Instructional Planning**

- 3.1 Curricular materials and their use in planning for classroom teaching
- 3.2 Operation calendar and its presentation
- 3.3 Annual and unit planning
- 3.4 Lesson planning: Models of lesson plan and micro-teaching planning
- 3.5 General aims and objectives in teaching mathematics and science: Goal, aims, objectives and behavioral objectives
- 3.6 Bloom's taxonomy for educational objectives, related action verbs and application of Bloom's approach and revised Bloom's taxonomy
- 3.7 Formulation of instructional objectives for teaching mathematics and science

- 3.8 Types, collection, preparation, uses and storing of instructional materials for teaching lower-secondary mathematics and science & environment

#### **4 Learning Theories and Psychologies**

- 4.1 Theories and type of motivation
- 4.2 Overview of different schools of thoughts in theories of learning
- 4.3 Learning theories of learning mathematics and science : Piaget's, Bruner's, Gagne's and Ausubel's theories
- 4.4 Constructivism as a theory of learning and instructions
- 4.5 Compare and contrast between different learning theories
- 4.6 Motivational factors in learning and thinking
- 4.7 Creativity and scientific attitudes
- 4.8 Role, professional competencies, subject competencies and challenges of mathematics and science teachers

#### **5 Teaching Methods and Instructional Strategies**

- 5.1 Concept and meaning of approaches, methods and techniques
- 5.1.1 Approaches: Inductive, deductive and heuristic
- 5.1.2 Methods: Lecture, demonstration, problem solving, laboratory, assignment, activity, project, inquiry, field trip
- 5.1.3 Modern techniques of science teaching: Project work, discussion, quiz, brainstorming, seminars
- 5.2 Teacher-centred versus student-centred strategies
- 5.3 Action research and its application in mathematics and science teaching
- 5.4 Teaching skills : Introduction skill, questioning skill, blackboard use skill, reinforcement skill, explanation skill, basic laboratory skills, skill of illustration with examples
- 5.5 Recent trends in mathematics and science education : Constructivism and constructivist method
- 5.6 Mathematics and science teaching through open and distance learning mode
- 5.7 Use of ICT in teaching mathematics and science
- 5.8 Interactive and inquiry teaching in mathematics and science education
- 5.9 Basic processes skills : Observing, time relationship, classifying, using numbers, measuring, communicating, predicting, inferring
- 5.10 Predict, observe and explain (POE) in teaching mathematics and science
- 5.11 Concept mapping

#### **6 Assessment of Students Performance**

- 6.1 Difference between examination, assessment and evaluation
- 6.2 Evaluation: Meaning, needs, types, technique, tools and their critical comparison
- 6.3 Types of test: Standardized test, teacher made test (subjective, objective) and diagnostic test

- 6.4 Construction and standardization of test items: Planning of test, specification chart, reliability and validity
  - 6.5 Authentic assessment and alternative assessment : Rubric, contineous assessment system (CAS), portfolio assessment, project work, homework and quiz, portfolio assessment
  - 6.6 Different techniques for scoring and use of test result: Point scoring, test item based scoring and analysis of scores
  - 6.7 Letter grading system : Grade descriptors, grade point and assigning grade
  - 6.8 Item and error analysis of district level examination of grade eight
  - 6.9 Efforts to improve the examination system, present status of examination system, their defects and suggestions to improve the evaluation system in Nepal
- 7 Teaching Mathematics and Science & Environment in Lower Secondary Level**
- 7.1 Teaching Mathematics in Lower Secondary Level**
    - 7.1.1 **Teaching geometry** : Line, angles, triangle, rectangle, polygons, similirities, congruencies, circle and geometrical solid objects
    - 7.1.2 **Teaching co-ordinate geometry** : Introduction, axis, ordinate, quadrant, co-ordinate, Pythagorous theorem and distance
    - 7.1.3 **Teaching measurement** : Perimeter, area and volume
    - 7.1.4 **Teaching transformation geometry** : Transformation, symmetry & tessellation, and scale drawing
    - 7.1.5 **Teaching set** : Introduction, symbols, types of set, subsets, overlapping & disjoint set, Venn diagram
    - 7.1.6 **Teaching arithmetic** : Whole number, proportionate numbers, real numbers, fraction & decimal, ratio, proportion and percentage, loss and profit, unitary method, simple interest
    - 7.1.7 **Teaching statistics** : Data, data collection, frequency table, cumulative table, line graph, bar graph, mean, median, mode, range and pie-chart
    - 7.1.8 **Teaching algebra** : Algebraic expression, indices, equation, inequality and graph
  - 7.2 Teaching Science & Environment in Lower Secondary Level**
    - 7.2.1 **Teaching physics** : Measurement, velocity and acceleration, simple machine, pressure, work, energy & power, pressure, light, sound, magnet and electricity
    - 7.2.2 **Teaching chemistry** : Materials, mixtures, metals & non-metals, acids, bases & salts and some useful chemicals
    - 7.2.3 **Teaching biology** : Biological beings, cell & tissue and life process
    - 7.2.4 **Teaching geology and astronomy** : Structure of earth, eclipses, weather & climate and earth & space

- 7.2.5 **Teaching environmental education** : Environment & its balance, environment degradation & its preservation and environment & sustainable development

**Section C. Content Knowledge of subject matter** **40 Marks**

**I. Content Knowledge in Mathematics** **20 Marks**

**8 Basics of Numbers, Its Extension and Logics**

- 8.1 Numbers and numerals, different numeration systems  
8.2 Set and set operations (theorems)  
8.3 Mathematical logic ( $\vee$ ,  $\wedge$ ,  $\neg$ , truth table, basic laws) and writing mathematical language  
8.4 Counting system: Combination and permutation  
8.5 Binomial theorem and mathematical induction  
8.6 Real and complex number system and algebra of complex numbers  
8.7 Sequence and series  
8.8 Sum of finite natural numbers ( $n$ ,  $n^2$ ,  $n^3$ )  
8.9 Intuition and principle of mathematical induction

**9 Basic Algebra and Its Extension**

- 9.1 Transition from arithmetic to algebra  
9.2 Relations, equivalence relations, binary operation and group structure  
9.3 Function, graphs and curve sketching  
9.4 Polynomials and rational function (relation between roots and coefficients)  
9.5 Exponential and logarithmic function  
9.6 Inverse of matrix and properties of determinants  
9.7 Cramer's rule in system of linear equation and quadratic equation  
9.8 System of inequalities and LPP solutions  
9.9 Binomial expansions  
9.10 Differential equations and their application

**10 Fundamental Trigonometry and Its Extension**

- 10.1 Trigonometric function and unit circle  
10.2 Radian and degree measure  
10.3 Solution of trigonometric equations  
10.4 Trigonometric equations and general values  
10.5 Properties, area and solution of triangle  
10.6 Inverse trigonometric function  
10.7 Sum, difference, multiple angles and product-sum formulae of trigonometric ratios  
10.8 DeMoivre's theorem,  $n^{\text{th}}$  roots and Euler's formula

## 11 Euclidean and Analytic Geometry

- 11.1 Fundamentals of Euclidean geometry: History and development, fundamental properties of Euclidean geometry and axiomatic system
- 11.2 Selected theorems on parallel lines, triangles, quadrilaterals and circles
- 11.3 Construction of triangle and quadrilateral
- 11.4 Curve sketching
- 11.5 Area and volume of plane and solid figure
- 11.6 Analytic geometry: History and development
- 11.7 Distance formula, equation of straight lines and pairs of straight lines
- 11.8 Definitions and graphical representation of conic sections
- 11.9 Circles and related theorems and problems
- 11.10 General concept of parabola, ellipse and hyperbola related

## 12 Descriptive Statistics and Probability

- 12.1 Discrete and continuous data generation, cumulative frequency distribution and frequency distribution and graphical representation of data
- 12.2 Measure of central tendency : Mean, median and mode
- 12.3 Measure of dispersion : Range, mean deviation, standard deviation, skewness and kurtosis
- 12.4 Measure of correlation and regression line
- 12.5 Simple probability, exclusive and independent events, tree diagram
- 12.6 Compound probabilities
- 12.7 Binomial probability distribution and its properties

## 13 Differential and Integral Calculus

- 13.1 Limit and continuity of functions and related problems
- 13.2 Derivatives of functions and related problems
- 13.3 Relation between derivatives and integration
- 13.4 Integration of given function and related problems
- 13.5 Application of derivatives and integration

## 14 Vector and Its Application

- 14.1 Definition and representation of vectors and different types of vectors
- 14.2 Operation on vectors: Addition, subtraction, scalar product and vector product with geometrical representations
- 14.3 Vector geometry : Line, triangles and quadrilaterals
- 14.4 Application of vectors in geometry and trigonometry
- 14.5 Co-ordinate in space

## II. Content Knowledge in Science

20 Marks

### 15 Physics

- 15.1 **Mechanics** : Measurement, scalar & vector quantities, motion, momentum, gravitation, simple harmonic motion, work, energy & power, pressure in fluid, pressure variation in atmospheric pressure and Archimede's principle
- 15.2 **Wave motion and sound** : Vibratory motion, waves, sound pollution, speed of sound and sonometer
- 15.3 **Optics** : Reflection & refraction of light, lenses, defects of vision, polarization of light, Newton's ring, and optical instruments
- 15.4 **Magnetism and electricity** : Magnetic elements, magnetic effect of current, Faraday's laws of electromagnetic induction, AC generator & dynamo and DC generator
- 15.5 **Heat** : Concept of heat and temperature and its units, thermometry, thermal expansion, thermodynamics and specific heat
- 15.6 **Electrostatic force** : Induction, types of charge, insulator and conductor and quantization of electric charge
- 15.7 **Modern physics** : Cathode rays, X-Rays, radioactivity, nuclear reaction and nuclear reactions in the sun
- 15.8 **Geology** : History of the earth, structure of the earth, types of rocks, green House effect, water cycle, natural disasters, minerals, volcano, earthquake, ozone layer and depletion of ozone layer
- 15.9 **Astronomy** : Important constituents of the universe, heliocentric theory, astronomical instruments, galaxies, stars, solar system, satellites, constellations, eclipses

### 16 Chemistry

- 16.1 **Language of chemistry** : Chemical arithmetic, atoms, molecules, elements & compounds, symbols, valency & formula, chemical equation, types, significances & limitations and balancing the chemical equation
- 16.2 **States of matter** : Three states of matter, basic concepts of kinetic theory of gases, equation of state, Dalton's law of partial pressure, Graham's law of diffusion, deviation from ideal behavior, laws of stoichiometry, Avogadro's hypothesis, relation between molecular weight & vapour density, properties of solid
- 16.3 **Atomic structure and valency** : Dalton's atomic theory, Rutherford's atomic model, Bohr's postulates, Aufbau principle, electronic configuration of atoms, theory of valency and basic principle of electrolysis
- 16.4 **Periodic classification and chemical equilibrium** : Mendeleef's periodic law, modern periodic law, periodic table, electronic configuration, chemical equilibrium equilibrium constant, ionization and electronegativity
- 16.5 **Acids, bases and salts and oxidation reduction** : Arrhenius, Bronsted-Lworry & Lewis concepts of acids, bases with suitable examples, oxidation and reduction and electronic interpretation of oxidation & reduction reaction
- 16.6 **Equivalent weight, acidimetry, alkalimetry and pH** : Definition of equivalent weight, equivalent weight of acid, base & salt, acidimetry & alkalimetry, simple acid-base titration and concept of pH



- 16.7 **Chemistry of metals** : Metals & metalloids, introduction to metallurgy, important processes in metallurgy, mineral resources of Nepal, extraction, properties & uses of the copper, zinc, iron, silver & sodium
- 16.8 **Chemistry of non-metals** : General preparation & properties of halogens, nitrogen & sulphur and its compounds, general preparation and properties of compounds of nitrogen and manufacture of  $\text{NH}_3$  &  $\text{H}_2\text{SO}_4$
- 16.9 **Carbon and its compounds** : Definition classification and uses of organic compounds, bonding & hybridization, empirical & molecular formulae, qualitative analysis of organic compounds, functional group & IUPAC nomenclature, introduction to aliphatic & aromatic hydrocarbons, general preparation and properties of alkane, alkene, alkyne, aldehyde, ketone, carboxylic acid & chloroform and lab preparation & properties of methane, ethane, ethyl alcohol, phenol, nitrobenzene, aniline & benzoic acid
- 16.10 **Uses of chemistry in daily life** : Insecticides, pesticides, simple drugs, polymers and fertilizers

## 17 Biology

- 17.1 **Introduction to biology** : Nature & scope of biology, branches of biology & its relationships with other branches of science, general concepts of life processes and human responsibility for the protection of earth and conservation of diverse life forms, impact of biological sciences on modern communities,
- 17.2 **Cell biology** : Prokaryotes & eukaryotes, structures of plant & animal cell, cell inclusions and cell organelles, mitosis & meiosis cell division, plant tissues & their function, animal tissues & their function, protoplasm, its physical & chemical nature, general structure and roles of carbohydrate, protein, amino acids, nucleic acids & lipids and the chromosome
- 17.3 **Continuity of life** : Mitosis, meiosis & their significance, laws of inheritance, mutation & its significance and concepts of hybrid and hybridization, significance of hybrid seeds for crop production.
- 17.4 **Evolution** : Theories of origin of life, biochemical concept of evolution and different views on organic evolution
- 17.5 **Physiological system of human** : Digestive, circulatory, respiratory, excretory, urinary, reproductive, muscular, skeleton nervous system & glandular system and human welfare
- 17.6 **Plants of economic importance**: Medicinal plants, fiber yielding plants, timber plants, vegetables, cereals, cash crops, beverage and fruits
- 17.7 **Animals of economic importance**: Domestic animals, earthworm, silkworm and honey bee
- 17.8 **Plant physiology** : Water relation, metabolism (photosynthesis, respiration), nitrogen fixation, growth, plant propagation and flowering plants
- 17.9 **Ecology** : Community, succession, adaptation, ecosystem, food chain, tropic levels, interactions of biotic & abiotic factors, productivity, ecological pyramids and bio-geo-chemical cycles (carbon and nitrogen)
- 17.10 **Study of the five kingdoms** : Monera, protista, plantae, fungi and animalia

- 17.11 **Environment & conservation** : Interaction of biotic & abiotic factors, ecological imbalance, human survival, pollution, green house effect, climate change, community forests , bio-diversities, conservation & its importance and national parks of Nepal and environmental governance in Nepal and sustainable development
- 17.12 **Co-curricular and non-formal approaches** : Activity approaches and non-formal methods of biological science teaching in terms of field trips (visit to botanical garden, zoo, park), gardening, maintenance of aquarium, vivarium.

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