

PM SHRI KENDRIYA VIDYALAYA

LESSON PLAN • GANITA MANJARI (PART II)

Date: 06/10/2026

Name of the teacher:	Class: IX	Unit / Lesson: Ch 9: Propositions & their Converses	Periods req.: 06
Designation: TGT (Mathematics)	Subject: Mathematics	Book: NCERT Ganita Manjari (Grade 9, Part II)	No. of students:

◆ Content

- **Propositions:** Definition of mathematical statements with definite truth values.
- **Converse of Statements:** Structure of 'If X then Y' vs 'If Y then X' (X implies Y).
- **Truth Relationships:** When propositions and their converses are both true, one true and other false, or both false.
- **Counterexamples:** Concept, role, and constructing valid counterexamples (Fermat primes & Euler's refutation).
- **Baudhāyana-Pythagoras:** Theorem and deductive proof of its converse via SSS congruence.

◆ Learning Outcomes (Lesson Specific)

- Differentiate between an open statement, a conjecture, and a proposition.
- Construct accurate converse formulations for geometric and numerical propositions.
- Recognize that the truth of a statement does not automatically guarantee the truth of its converse.
- Disprove flawed claims using concise counterexamples across arithmetic and geometric domains.
- Justify geometric converses systematically using formal triangle congruence conditions (ASA/SSS).

◆ Pedagogical Strategies

- **Inquiry-Based Dialogue:** Begin with real-life conditionals: "If it rains, the road is wet" vs "If the road is wet, it rained."
- **Peer Counterexample Hunt:** Provide flawed conjectures (e.g., "All numbers $4n^2 + 1$ are prime") for group refutation.
- **Baudhāyana-Pythagoras Lab:** Reconstruct auxiliary right triangle $\triangle XYZ$ with legs a, b to establish congruence with $\triangle ABC$.
- **Graphic Organizers:** Truth-table style sorting of statements from geometry and number theory.

■ Integration

- **Logic & CS:** Boolean conditional logic, 'if-then' branches.
- **Language Arts:** Syntax of implication and converses.
- **Scientific Method:** Falsifiability of hypotheses via counterexamples.

■ Assessment Strategies

- **For:** Quick diagnostic on phrasing converses of divisibility rules.
- **As:** Peer review of counterexamples for Exercise 9.1 (Q13-14).
- **Of:** Rubric-graded short proof of the converse of Pythagoras theorem.

■ Resources

- NCERT Ganita Manjari Part II (Ch 9, pp. 1-7).
- DIKSHA QR portal interactive worksheets.
- Sentence strip flashcards for premise/conclusion sorting.

■ 21st C. Skills / Values

- **Critical Thinking:** Skepticism towards unproven generalizations.
- **Logical Rigour:** Precision in mathematical reasoning.
- **Open-mindedness:** Celebrating errors as refutation tools.

► **Real-life Application:** Legal contracts, diagnostic medicine (e.g., "If patient has dengue, platelets drop" does not mean "If platelets drop, patient has dengue"), traffic law enforcement, and computer code bug detection rely fundamentally on non-reversible logical propositions and finding edge-case counterexamples.

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LESSON PLAN • GANITA MANJARI (PART II)

Date: 14/10/2026

Name of the teacher: [Teacher Name]	Class: IX	Unit / Lesson: Ch 10: How Quantities Combine: Understanding Data	Periods req.: 12
Designation: TGT (Mathematics)	Subject: Mathematics	Book: NCERT Ganita Manjari (Grade 9, Part II)	No. of students: 42

◆ Content

- **Average of Averages:** Limitations of simple means when sample sizes vary.
- **Weighted Average:** Formula $x = \frac{\sum(w_i x_i)}{\sum w_i}$.
- **Historical Roots:** Brahmagupta (c. 628 CE) pit depth, Śrīdharācārya (c. 750 CE) gold purity (varna/karats).
- **Mixtures & Ratings:** Concentration of solutions and weighted scoring.
- **Data Visualisation:** Stacked vs 100% stacked bar charts; comparisons vs proportions.

◆ Learning Outcomes (Lesson Specific)

- Explain why simple average of subgroup averages fails when group sizes are unequal.
- Compute weighted arithmetic mean across mixtures, composite scores, and combined datasets.
- Select between clustered, stacked, and 100% stacked bar charts based on analytical purpose.
- Deduce valid conclusions from 100% stacked charts while identifying inferences requiring raw totals.
- Connect ancient Indian mathematical contributions to contemporary data science.

◆ Pedagogical Strategies

- **Experiential Inquiry:** Solve the 'Badminton Academy Height' and 'Lemonade & Jaggery' dilemmas in collaborative pairs.
- **Data Literacy Lab:** Analyze real-world datasets: National Time Use Survey 2024 and IUCN Red List stacked charts.
- **Simulation:** Model hotel rating schemes (Food: Ambience: Service = 6:5:4) using spreadsheet tables.
- **Debate & Critique:** "What Can a 100% Stacked Chart Hide?" (Fatima vs Naveen garden blooms).

■ Integration

- **Chemistry:** Solution concentrations, titration, alloy metallurgy.
- **Social Studies:** National Time Use Survey, Census disability stats.
- **Economics:** Consumer price indices, weighted inflation.

■ Assessment Strategies

- **For:** Quick check on whether weights affect the mean when doubled.
- **As:** Self-reflection on personal daily time-use stacked bar chart.
- **Of:** Group project designing custom rating schemes (Ex 10.5 Q13).

■ Resources

- NCERT Ganita Manjari Part II (Ch 10, pp. 8-36).
- Real survey data infographics (Stats of India, IUCN).
- Graph sheets, color markers, calculators.

■ 21st C. Skills / Values

- **Data Literacy:** Uncovering misleading visual representations.
- **Decision Making:** Weighing priorities in multi-criteria evaluation.
- **Cultural Rootedness:** Respect for Indian mathematical legacy.

► **Real-life Application:** Calculating CBSE board internal assessment weightages (3:2:5), e-commerce customer star ratings (Amazon/Zomato), stock portfolio weighted average purchase prices, and saline medical fluid preparations.

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LESSON PLAN • GANITA MANJARI (PART II)

Date: 28/10/2026

Name of the teacher: [Teacher Name]	Class: IX	Unit / Lesson: Ch 11: The World of Algorithms	Periods req.: 08
Designation: TGT (Mathematics)	Subject: Mathematics	Book: NCERT Ganita Manjari (Grade 9, Part II)	No. of students: 42

◆ Content

- **Definition:** Algorithms as deterministic, step-by-step procedures.
- **Digit-by-Digit Addition:** Place-value column addition algorithm, carry logic, and grouping proof.
- **GCD Approaches:** Divisor listing, combined scanning, and eliminating storage lists.
- **Data Structures:** Ordered lists as containers for systematic processing.
- **Refinement:** Euclid's subtraction $\gcd(n, m-n)$ to Āryabhata's division algorithm $\gcd(n, m \bmod n)$.
- **History:** Al-Khwarizmi, Latin *algorithmus*, and Indian decimal numerals.

◆ Learning Outcomes (Lesson Specific)

- Define and formulate unambiguous algorithms using formal loops and conditionals.
- Articulate the place-value mathematical justification for traditional column addition.
- Trace, execute, and debug algorithms manually step-by-step using trace tables.
- Prove geometric and algebraic tiling validity of Euclid's step: $\gcd(m, n) = \gcd(n, m - n)$.
- Explain why Āryabhata's modulo reduction scales with number of digits rather than absolute value.

◆ Pedagogical Strategies

- **Unplugged Activity:** "Human Computers" - students act as registers, carries, and pointers to execute column addition.
- **Tiling Demonstration:** Visual bar tiling showing that any unit block d dividing m and n also tiles $(m - n)$.
- **Comparative Benchmarking:** Race between subtraction-based reduction and modulo-division for $\gcd(99, 2)$.
- **Historical Storytelling:** Transmission of Indian place-value algorithms to Baghdad and medieval Europe.

■ Integration

- **Computer Science:** Pseudocode, arrays, iteration, computational complexity.
- **History & Heritage:** Āryabhata's Kuṭṭaka and House of Wisdom scholarship.
- **Linguistics:** Etymology of "algorithm" and formal precision.

■ Assessment Strategies

- **For:** Tracing list state during execution of divisors(18) algorithm.
- **As:** Peer debugging of algorithm for finding LCM of two numbers (Ex 11.2).
- **Of:** Formal written test on executing Āryabhata's division algorithm for 7-digit pairs.

■ Resources

- NCERT Ganita Manjari Part II (Ch 11, pp. 37-50).
- Step-by-step algorithm trace worksheets.
- Cuisenaire rods / grid blocks for tiling divisor demonstration.

■ 21st C. Skills / Values

- **Computational Thinking:** Algorithmic decomposition & abstraction.
- **Efficiency Mindset:** Optimizing procedures for speed and space.
- **Systematic Rigour:** Absolute clarity in giving instructions.

► **Real-life Application:** GPS navigation route finding, digital banking RSA encryption (which relies directly on fast modular arithmetic and greatest common divisors), search engine indexing, and automated barcode scanners.

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LESSON PLAN • GANITA MANJARI (PART II)

Date: 10/11/2026

Name of the teacher: [Teacher Name]	Class: IX	Unit / Lesson: Ch 12: Quadrilaterals	Periods req.: 14
Designation: TGT (Mathematics)	Subject: Mathematics	Book: NCERT Ganita Manjari (Grade 9, Part II)	No. of students: 42

◆ Content

- **Definitions:** Rigorous 4-gon definition; convex vs non-convex (dent), self-intersecting, and non-planar.
- **Parallelograms:** 4 converses (equal sides, equal angles, bisecting diagonals, equal-parallel pair).
- **Midpoint Theorem:** Statement, proof via auxiliary line, and its converse (uniqueness of parallel line).
- **Centroid Theorem:** 2:1 median ratio proof via midpoint bisection.
- **Varignon's Theorem:** Midpoint parallelogram of any 4-gon.
- **Plane Tiling:** 180° rotation and Varignon grid tiling for any arbitrary quadrilateral.

◆ Learning Outcomes (Lesson Specific)

- Distinguish between convex, non-convex, and skew quadrilaterals with precise geometric criteria.
- Establish that a quadrilateral is a parallelogram using any of the four converse criteria.
- Deduce the Midpoint Theorem and its converse using triangle congruences and auxiliary parallel lines.
- Prove that medians of a triangle concur at a centroid dividing them in 2:1 ratio.
- Apply Varignon's Theorem and demonstrate how any arbitrary 4-gon can tile the entire 2D plane.

◆ Pedagogical Strategies

- **Hands-On Paper Folding:** Fold triangle sides to find midpoints; verify 4 congruent sub-triangles.
- **Linkage Mechanism Model:** Use linked cardboard strips and pins to demonstrate 4-bar linkages and pantographs.
- **Tile-the-Plane Workshop:** Cut 15 identical copies of an irregular quadrilateral 'SOME' and assemble tessellations.
- **Deductive Proof Seminars:** Students present blackboard justifications for converse theorems.

■ Integration

- **Mechanical Engg:** James Watt's parallel motion linkage, pantograph scalers.
- **Art & Design:** M.C. Escher tessellations, Islamic geometric tile patterns.
- **Materials Science:** Aperiodic tilings and 2011 Nobel quasicrystals.

■ Assessment Strategies

- **For:** Concept-check on whether a quadrilateral with equal diagonals is a rectangle.
- **As:** Student self-assessment reconstructing $\triangle ABC$ from given midpoint triangle.
- **Of:** Formal test proving the Midpoint Theorem and Varignon's theorem.

■ Resources

- NCERT Ganita Manjari Part II (Ch 12, pp. 51-84).
- Cardboard linkage kits with paper fasteners.
- Tracing paper, scissors, geometric drawing instruments.

■ 21st C. Skills / Values

- **Spatial Reasoning:** Visualizing rotations and 3D skew shapes.
- **Aesthetic Appreciation:** Harmony of geometric tessellations.
- **Perseverance:** Developing non-obvious auxiliary constructions.

► **Real-life Application:** Structural scissor lifts, folding security gates, steam engine Watt linkages, drafting drafting pantographs, floor tile manufacturing without gaps, and architectural geodesic structures.

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LESSON PLAN • GANITA MANJARI (PART II)

Date: 01/12/2026

Name of the teacher: [Teacher Name]	Class: IX	Unit / Lesson: Ch 13: Two Variables, One Line	Periods req.: 14
Designation: TGT (Mathematics)	Subject: Mathematics	Book: NCERT Ganita Manjari (Grade 9, Part II)	No. of students: 42

◆ Content

- **Linear Equations:** Standard form $ax + by + c = 0$, coefficients, and infinite solution pairs.
- **Slope-Intercept Form:** $y = mx + d$, Rise over Run, vertical/horizontal slopes, and y-intercept d .
- **Systems of Equations:** Modeling real-life situations with pairs of linear equations.
- **Algebraic Methods:** Method of Substitution and Method of Elimination.
- **Geometric Classification:** Intersecting (unique), parallel (no solution), and coincident (infinitely many) lines via coefficient ratios a_1/a_2 , b_1/b_2 , c_1/c_2 .
- **History:** Ancient Chinese *fangcheng* and Indian methods.

◆ Learning Outcomes (Lesson Specific)

- Represent real-world financial/word scenarios as linear equations in two variables.
- Calculate, interpret, and graph the slope and intercepts of lines in Cartesian planes.
- Solve simultaneous linear equations fluently using substitution and elimination methods.
- Predict the geometric relationship of two lines purely by inspecting ratio of coefficients.
- Graph pairs of lines accurately to locate their unique solution as the intersection coordinate.

◆ Pedagogical Strategies

- **Contextual Engagement:** The fruit vendor dilemma ($60x + 50y = 280$) and restaurant billing problems.
- **Kinesthetic Slope Model:** Physical steepness walking / wheelchair accessibility ramp design (1:12 slope).
- **Graphical Verification Lab:** Plotting pairs of equations on graph paper to visualize intersection vs parallelism.
- **Ancient Problem Challenge:** Solving Mahaviracharya's Ganita Sara Sangraha (c. 850 CE) citron and apple problem.

■ Integration

- **Physics:** Uniform velocity graphs, Celsius to Fahrenheit conversion ($F = 9/5 C + 32$).
- **Architecture:** ADA ramp slopes, roofing pitches.
- **Commerce:** Break-even analysis, comparing mobile plans.

■ Assessment Strategies

- **For:** Rapid classification of coefficient ratios into solution categories.
- **As:** Student error-analysis of substitution steps in fractional systems.
- **Of:** Unit test solving applied word problems algebraically and graphically.

■ Resources

- NCERT Ganita Manjari Part II (Ch 13, pp. 85-122).
- Millimeter graph sheets and plotting scales.
- Coordinate geometry digital applets / GeoGebra.

■ 21st C. Skills / Values

- **Mathematical Modeling:** Translating language into equations.
- **Analytical Thinking:** Dual perspective (algebraic vs visual).
- **Problem Solving:** Optimizing multi-variable constraints.

► **Real-life Application:** Comparing mobile tariff plans (fixed charge vs per-minute rate), calculating taxi fares, temperature unit conversions, civil engineering ramp gradients, and supply-demand market equilibrium points.

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LESSON PLAN • GANITA MANJARI (PART II)

Date: 04/01/2027

Name of the teacher: [Teacher Name]	Class: IX	Unit / Lesson: Ch 14: Math of Space: Surface Area & Volume	Periods req.: 16
Designation: TGT (Mathematics)	Subject: Mathematics	Book: NCERT Ganita Manjari (Grade 9, Part II)	No. of students: 42

◆ Content

- **Cuboids & Cubes:** $TSA = 2(lw + wh + hl)$, Volume = lwh via stacked card principle.
- **Right Circular Cylinder:** $CSA = 2\pi rh$, $TSA = 2\pi r(h+r)$, Volume = $\pi r^2 h$ via unrolled rectangle & stacked discs.
- **Cones:** Slant height $l^2 = r^2 + h^2$, $CSA = \pi rl$, $TSA = \pi r(l+r)$, Volume = $\frac{1}{3} \pi r^2 h$.
- **Pyramids:** Volume = $\frac{1}{3} \times \text{base area} \times \text{height}$ for any polygonal base.
- **Spheres & Hemispheres:** Archimedes' cylinder theorem, Sphere $SA = 4\pi r^2$, Volume = $\frac{4}{3} \pi r^3$; Hemisphere $CSA = 2\pi r^2$, $TSA = 3\pi r^2$, Volume = $\frac{2}{3} \pi r^3$.
- **Guesstimates:** Order-of-magnitude Fermi modeling and packing fractions.

◆ Learning Outcomes (Lesson Specific)

- Calculate surface areas and volumes of composite and fundamental 3D solids accurately.
- Demonstrate experimentally why a cone has exactly one-third the volume of a matching cylinder.
- Verify the surface area of a sphere using the string-winding and 4-circle unwinding method.
- Formulate order-of-magnitude guesstimates using clear geometric approximations and packing limits.
- Appreciate Archimedes' geometric discoveries and their links to cartography map projections.

◆ Pedagogical Strategies

- **Hands-On Salt Experiment:** Fill cone with fine salt and transfer into matching cylinder to verify the 1:3 volume ratio.
- **String Winding Activity:** Wind thread on a rubber ball and transfer into four circles of radius r to verify $4\pi r^2$.
- **3D Net Folding:** Cut and assemble nets of cuboids, cylinders, cones, and pyramids from the textbook appendix.
- **Fermi Estimation Circle:** Solve the "Golgappa Pani" and "Tennis balls in a classroom" guesstimates in small groups.

■ Integration

- **Biology:** Surface area to volume ratio in cell size & heat regulation.
- **Geography:** Cylindrical map projection distortions (Greenland vs equator).
- **Culinary Arts:** Beverage dispensing and packaging volume.

■ Assessment Strategies

- **For:** Quick calculations on slant height using Pythagoras triples.
- **As:** Peer estimation of classroom brick counts with explicit error bounds.
- **Of:** Practical assessment measuring volume and surface area of real vessels.

■ Resources

- NCERT Ganita Manjari Part II (Ch 14, pp. 123-148).
- Solid models (cylinder, cone, sphere, hemisphere, pyramid).
- Fine salt, plasticine clay, thread, measuring tape, caliper.

■ 21st C. Skills / Values

- **Estimation Competency:** Sensible approximations under uncertainty.
- **Spatial Visualization:** Transforming 2D nets into 3D objects.
- **Resource Conservation:** Minimizing packaging surface waste.

► **Real-life Application:** Designing cylindrical grain silos, water storage sumps, painting hemispherical temple/monument domes, computing tarpaulin needs for conical circus tents, optimizing packaging material in logistics, and estimation of bulk quantities.

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