

Scheme of studies for Bachelor of Science in Chemistry valid from Session Fall 2025.

Degree Title: Bachelor of Science in Chemistry

Degree Title with major

Bachelor of Science in Chemistry (Organic)

Bachelor of Science in Chemistry (Inorganic)

Bachelor of Science in Chemistry (Physical)

Bachelor of Science in Chemistry (Analytical)

Total Credit Hours	139
General Education	34 credit hours (15 courses + 2 courses understanding of Holy Quran)
Discipline Related Courses / Major	81 credit hours (27 courses)
Interdisciplinary / Allied Courses	18 credit hours (6 courses)
Internship	3 credit hours
Capstone	3 credit hours
Program Duration	Minimum: 4 years (8 regular semesters) Maximum: 6 years (12 regular semesters) The maximum limit is further extendable in accordance with HEC semester rules
Semester Duration	16-18 weeks for regular semesters (1-2 weeks for examination) 8-9 weeks for summer semesters (1 week for examination)
Course Load (per semester)	15-18 credit hours for regular semesters Up-to 8 credit hours for summer semesters (for remedial/deficiency/failure/repetition courses only)
3 Credit Hours (Theory)	3 classes (1 hour each) OR 2 classes (1.5 hour each) OR 1 class (3 hours) per week throughout the semester
1 Credit Hours (Lab / Field Work)	1 credit hour in laboratory or practical work / project requires lab contact of 3 hours per week throughout the semester

SEMESTER 1			
Course Code	Course	Credit Hours	Category
ENG-1107	Functional English	3 (3-0)	General Education
	Natural Science*	3 (2-1)	General Education
QTR-1124	Quantitative Reasoning – I	3 (3-0)	General Education
ICT-1126	Applications of ICT	3 (2-1)	General Education
CHEM-1141	Fundamentals of Chemistry	3 (2-1)	Major
CHEM-1142	Principles of Biochemistry	3 (2-1)	Interdisciplinary
TOTAL CREDIT HOURS: 18			
* MAT-1115 Mathematics for chemists with MATLAB, PHY-1118 Fundamentals of Physics			
SEMESTER 2			
Course Code	Course	Credit Hours	Category
ENG-1207	Expository Writing	3 (3-0)	General Education
PS-1217	Pakistan Studies	2 (2-0)	General Education
QTR-1224	Quantitative Reasoning-II	3 (3-0)	General Education
UHQ-1230	Understanding of Holy Quran-I	1 (0-1)	General Education
CHEM-1243	Principles of Organic Chemistry	3 (2-1)	Major
CHEM-1244	Principles of Inorganic Chemistry	3 (2-1)	Major
CHEM-1245	Principles of Physical Chemistry	3 (2-1)	Major

TOTAL CREDIT HOURS: 18			
SEMESTER 3			
Course Code	Course	Credit Hours	Category
ISL-2312	Islamic Studies/ethics (for non muslims)	2 (2-0)	General Education
ICP-2327	Ideology and Constitution of Pakistan	2 (2-0)	General Education
CHEM-2346	Principles of Analytical Chemistry	3 (2-1)	Major
CHEM-2347	Fuel Chemistry	3 (2-1)	Major
CHEM-2348	Principles of Polymer Chemistry	3 (2-1)	Major
CHEM-2349	Introduction to Nano-chemistry	3 (2-1)	Major
	Arts and Humanities*	2 (2-0)	General Education
TOTAL CREDIT HOURS: 18			
* ARA-2301 Arabic			
SEMESTER 4			
Course Code	Course	Credit Hours	Category
ETRE-2408	Entrepreneurship	2 (2-0)	General Education
CCE-2425	Civics and Community Engagement	2 (2-0)	General Education
CHEM-2450	Forensic Chemistry	3 (2-1)	Major
CHEM-2451	Industrial Chemistry	3 (2-1)	Major
CHEM-2452	Environmental Chemistry	3 (2-1)	Major
CHEM-2453	Pharmaceutical Chemistry	3 (2-1)	Major

	Social Sciences*	2 (2-0)	General Education
TOTAL CREDIT HOURS: 18			
* one of these courses: LAW-2303: Political Science, PSY-2319: Educational Psychology, EDU-2304: Educational leadership and Management SOC-2321: Introduction to Sociology			
SEMESTER 5			
Course Code	Course	Credit Hours	Category
CHEM-3543	Advanced Organic Chemistry	3 (2-1)	Major
CHEM-3544	Advanced Inorganic Chemistry	3 (2-1)	Major
CHEM-3545	Advanced Physical Chemistry	3 (3-0)	Major
CHEM-3546	Advanced Analytical Chemistry	3 (2-1)	Major
CHEM-3554	Soil Chemistry	3 (2-1)	Major
CHEM-3555	Computational Chemistry	3 (2-1)	Major
TOTAL CREDIT HOURS: 18			
Major Organic Chemistry SEMESTER 6			
Course Code	Course	Credit Hours	Category
UHQ-3630	Understanding of Holy Quran-II	1(0-3)	General Education
CHEM-3656	Agricultural Chemistry	3 (2-1)	Major
CHEM-3657	Spectroscopy-I (Elective -I)	3 (3-0)	Major
CHEM-3658	Scientific Writing and Research Methods	3 (3-0)	Interdisciplinary
CHEM-3659	Statistics for Chemists	3 (3-0)	Interdisciplinary
	Elective – II *	3 (3-0)	Major

TOTAL CREDIT HOURS: 16			
Elective – II * *Any one of these CHEM-3660 Organometallics CHEM-3661 Organic Synthesis-I			
SEMESTER 7			
Course Code	Course	Credit Hours	Category
CHEM-4762	Chemical Safety and Risk Management	3 (3-0)	Major
CHEM-4763	Materials Science	3 (2-1)	Interdisciplinary
CHEM-4764	Internship	3 (0-3)	Compulsory
	Elective – III **	3 (3-0)	Major
	Elective – IV **	3 (3-0)	Major
	Elective – V **	3 (3-0)	Major
TOTAL CREDIT HOURS: 18			
**Any of these CHEM-4741 Reaction Mechanism-I CHEM-4742 Spectroscopy-II CHEM-4743 Stereochemistry CHEM-4744 Organic Synthesis-II			
SEMESTER 8			
Course Code	Course	Credit Hours	Category
	Elective – VI ***	3	Major
	Elective – VII ***	3	Major
CHEM-4865	Artificial Intelligence in Chemistry *****	3 (2-1)	Interdisciplinary
CHEM-4866	Quality Control and Assurance	3 (2-1)	Interdisciplinary
CHEM-4870	Capstone	3 (0-3)	Capstone
TOTAL CREDIT HOURS: 15			

*****Any of These**

CHEM-4841 **Reaction Mechanism-II**

CHEM-4842 **Name Reactions**

CHEM-4843 **Natural Products Chemistry**

CHEM-4844 **Heterocyclic Chemistry**

Major Inorganic Chemistry

SEMESTER 6

Course Code	Course	Credit Hours	Category
UHQ-3630	Understanding of Holy Quran-II	1 (0-1)	General Education
CHEM-3656	Agricultural Chemistry	3 (2-1)	Major
CHEM-3657	Spectroscopy-I (Elective-I)	3 (3-0)	Major
CHEM-3660	Organometallics (Elective-II)	3 (3-0)	Major
CHEM-3658	Scientific Writing and Research Methods	3 (3-0)	Interdisciplinary
CHEM-3659	Statistics for Chemists	3 (3-0)	Interdisciplinary

TOTAL CREDIT HOURS: 16

SEMESTER 7

Course Code	Course	Credit Hours	Category
CHEM-4762	Chemical Safety and Risk Management	3 (3-0)	Major

CHEM-4763	Materials Science	3 (2-1)	Interdisciplinary
CHEM-4764	Internship	3 (0-3)	Compulsory
	Elective – III **	3	Major
	Elective – IV **	3	Major
	Elective – V **	3	Major

TOTAL CREDIT HOURS: 18

****Any of these**

CHEM-4721 **Inorganic Reaction Mechanism**

CHEM-4722 **Symmetry and Magnetochemistry**

CHEM-4723 **Pi acceptor ligands and inorganic polymers**

CHEM-4724 **Nuclear and Radiochemistry**

SEMESTER 8

Course Code	Course	Credit Hours	Category
	Elective – VI ***	3	Major
	Elective – VII ***	3	Major
CHEM-4865	Artificial Intelligence in Chemistry *****	3 (2-1)	Interdisciplinary
CHEM-4866	Quality Control and Assurance	3 (2-1)	Interdisciplinary
CHEM-4870	Capstone	3 (0-3)	Capstone

TOTAL CREDIT HOURS: 15

***** Any of these**

CHEM-4821 **Coordination Chemistry**

CHEM-4822 **Inorganic Electronic Spectroscopy**

CHEM-4823 **Chemical Crystallography**

CHEM-4824 **Bioinorganic Chemistry**

Major Physical Chemistry

SEMESTER 6

Course Code	Course	Credit Hours	Category
UHQ-3630	Understanding of Holy Quran-II	1 (0-1)	General Education
CHEM-3656	Agricultural Chemistry	3 (2-1)	Major
CHEM-3658	Scientific Writing and Research Methods	3 (3-0)	Interdisciplinary
CHEM-3659	Statistics for Chemists	3 (3-0)	Interdisciplinary
	Elective – I*	3 (3-0)	Major
	Elective – II*	3 (3-0)	Major

TOTAL CREDIT HOURS: 16

***Any of these**

CHEM-3667 **Reaction dynamics**

CHEM-3668 **Radiation and photochemistry**

CHEM-3669 **Polymer Chemistry**

SEMESTER 7

Course Code	Course	Credit Hours	Category
CHEM-4763	Materials Science	3 (2-1)	Interdisciplinary
CHEM-4764	Internship	3 (0-3)	Compulsory
CHEM-4762	Chemical Safety and Risk Management	3 (3-0)	Interdisciplinary
	Elective – III **	3	Major
	Elective – IV **	3	Major
	Elective – V **	3	Major

TOTAL CREDIT HOURS: 18

****Any of these**

CHEM-4701 Quantum Chemistry and Molecular Spectroscopy			
CHEM-4702 Chemical Kinetics			
CHEM-4703 Electrochemistry			
CHEM-4704 Surface Chemistry and Catalysis			
SEMESTER 8			
Course Code	Course	Credit Hours	Category
	Elective – VI ***	3 (3-0)	Major
	Elective – VII ***	3 (3-0)	Major
CHEM-4865	Artificial Intelligence in Chemistry *****	3 (2-1)	Interdisciplinary
CHEM-4866	Quality Control and Assurance	3 (2-1)	Interdisciplinary
CHEM-4870	Capstone	3 (0-3)	Capstone
TOTAL CREDIT HOURS: 15			
*** Any of these CHEM-4801 Molecular Spectroscopy CHEM-4802 Colloidal and Solution Chemistry CHEM-4803 Chemical Thermodynamics CHEM-4804 Radiation and Nuclear Chemistry			

Major Analytical Chemistry			
SEMESTER 6			
Course Code	Course	Credit Hours	Category
UHQ-3630	Understanding of Holy Quran-II	1 (0-1)	General Education
CHEM-3656	Agricultural Chemistry	3 (2-1)	Major
CHEM-3658	Scientific Writing and Research Methods	3 (3-0)	Interdisciplinary

CHEM-3659	Statistics for Chemists	3 (3-0)	Interdisciplinary
	Elective – I*	3 (3-0)	Major
	Elective – II*	3 (3-0)	Major
TOTAL CREDIT HOURS: 16			
*Any of these CHEM-3670 Food and Drug Analysis CHEM-3671 Advanced Separation techniques CHEM-3672 Spectroscopic Methods of Analysis			
SEMESTER 7			
Course Code	Course	Credit Hours	Category
CHEM-4762	Chemical Safety and Risk Management	3 (3-0)	Major
CHEM-4763	Materials Science	3 (2-1)	Interdisciplinary
CHEM-4764	Internship	3 (0-3)	Compulsory
	Elective – III **	3 (3-0)	Major
	Elective – IV **	3 (3-0)	Major
	Elective – V **	3 (3-0)	Major
TOTAL CREDIT HOURS: 18			
**Any of these CHEM-4781 Thermal Methods of Analysis CHEM-4782 Nuclear Techniques CHEM-4783 Chromatographic Methods of Analysis CHEM-4784 Atomic Spectroscopy			
SEMESTER 8			
Course Code	Course	Credit Hours	Category
	Elective – VI ***	3	Major
	Elective – VII ***	3	Major
CHEM-4865	Artificial Intelligence in Chemistry	3 (2-1)	Interdisciplinary

CHEM-4866	Quality Control and Assurance	3 (2-1)	Interdisciplinary
CHEM-4870	Capstone	3	Capstone
TOTAL CREDIT HOURS: 15			
*** Any of these CHEM-4881 Advanced Hyphenated Techniques CHEM-4882 Advanced Mass Spectrometry CHEM-4883 Molecular Spectroscopy			

Note: General education courses are provided by the respective departments and are approved from the statutory bodies. These courses are uniform for the faculty of natural and applied sciences.

*, **, *** The elective courses are already approved in existing/previous scheme of study, and the course codes will be adjusted accordingly.

Degree award Requirements

The following minimum requirements are prescribed for award of Bachelor of Science in Chemistry:

- All courses in the General Education category with titles and credit hours as prescribed in the HEC Undergraduate Education Policy V 1.1. including the course of “Pakistan Studies” must be completed.
- Minimum of 139 credit hours as prescribed in this document must be completed.
- Capstone of 3 credit hours must be completed in accordance with HEC Undergraduate Education Policy V 1.1. This requirement cannot be substituted with additional coursework or internship. Internship is already included in the minimum 139 credit hours prescribed for the degree program.
- Internship of 3 credit hours, as per the University/FN&AS internship policy
- CGPA must not be below 2.00/4.00 at the time of completion of the degree program. The university may however set higher standard in this regard.
- The minimum duration to complete the degree program is as the University rules and HEC guidelines. Summer / winter semester is not considered as a regular semester.

Deficiency Courses:

Higher Secondary School Certificate (involving 12 years of schooling) or an IBCC equivalent qualification in any **science group** is the basic eligibility requirement for admission in the Bachelor of Science in Chemistry. For students, **who have not studied the subject of Chemistry or General Chemistry in prior qualification** (like DAE etc.), must study two deficiency courses namely “General Chemistry – I” and “General Chemistry – II”. Passing these subjects is mandatory for student’s further continuation in the BS program.

Course Code	Course Title	Credit Hours	Category
CHEM-1104	General Chemistry – I	3 (2-1)	Deficiency
CHEM-1105	General Chemistry – II	3 (2-1)	Deficiency
TOTAL CREDIT HOURS: 06			

Semester-I

Course Code: CHEM-1141

Fundamentals of Chemistry

CrHr: 3 (2-1)

Course Objectives

By the end of the course, students will be able to:

1. Describe scientific methods, report correct number of significant figures and dimensional analysis
2. Describe the structure of atom and periodic table
3. Understand and apply concept of mole and interpret chemical formula and balance equations
4. Describe the properties of solids, liquids, gases and solutions
5. Understand the concept of acids and bases, pH scale

Course Contents

Introduction to Chemistry: Chemistry in the modern world and important branches of chemistry. **Measurements:** Mass, length, volume, and temperature, SI and metric units, Significant figures and scientific notation. **Classification and properties of matter:** Physical states of matter, Pure substances and mixtures, physical and chemical properties, physical and chemical changes, energy, heat, and specific heat capacity. **Early atomic theory and modern atomic structure:** Atoms and Dalton's atomic theory, subatomic particles and atomic structure, atomic number and mass number, Isotopes and average atomic mass. **The Periodic Table:** Periods and groups, elemental symbols, metals, nonmetals, and metalloids, valence electrons and ion formation. **Composition of compounds:** Law of definite proportions and law of multiple proportions, Molecular compounds and molecules, Ionic compounds and formula units, **Quantitative composition of compounds:** The mole and Avogadro's number, molar mass, mass percent composition, empirical and molecular formulas. **Chemical reactions:** Combination, decomposition, single and double-displacement reactions, solubility of ionic compounds and aqueous reactions, exothermic and endothermic reactions. **Quantities in chemical reactions:** The concept of stoichiometry and mole ratios, Mole-mole, mole-mass, and mass-mass calculations, limiting reactants, Theoretical yield and percent yield. **Solutions:** Common types of solutions, solubility and saturation.

Acids and bases: Arrhenius theory and dissociation versus ionization, Brønsted-Lowry theory and conjugate acid-base pairs and Lewis acid base concept, strength of acids and bases (K_a , K_b , pK_a and pK_b). The pH scale and pH calculations.

Lab

Determining density: Observe and record mass and volume data, explore whether density of a substance depends on sample size, Determine the density of an unknown object and identify the composition using a provided list of substances. **Preparation of Solution:** Molar, molal, normal, percentage composition. **Resolving a two-component mixture:** Use physical separation methods including decantation, gravity filtration, evaporation, and extraction to

separate and recover the components of a binary mixture, Calculate the percent composition of each component in the mixture and percent recovery of the components. Salt Analysis. **Determining the percent of water in an unknown hydrate:** Learn the proper use of a Bunsen burner, explore whether the percent water in a hydrate depends on sample size, Calculate the theoretical percent water to evaluate the accuracy of the experimentally determined percent water.

CHEM-1142

Principles of Biochemistry

Cr Hr: 3 (2-1)

Course Objectives

By the end of this course, the students will be able to;

1. Explain principles governing the structure and function of biomacromolecules.
2. Metabolic pathways and their relevance to cellular function and health.
3. Understand real life applications of biochemistry such as medicine, biotechnology etc.

Course Contents:

Introduction; Scope of Biochemistry, cell structure and their functions, origin and nature of biomolecules. **Carbohydrates;** structure, classification, Physical and chemical properties of various classes of carbohydrates, biological functions of glucose, fructose, lactose, starch, glycogen, cellulose. **Lipid's;** structure and classification, chemistry and biological importance of fatty acids, waxes, glycerides, phospholipids, and glycolipids. **Protein;** structure and classification, physical and chemical properties of amino acids, biological significance of amino acids, peptides, proteins. Nucleic Acids, chemical composition of nucleic acids, structure and biological function of nucleic acids. **Vitamins;** types and their functions. **Enzymes;** properties, nomenclature, classification. Pharmaceutical and industrial implications of Biochemistry.

Lab:

Qualitative and quantitative tests for Carbohydrates, Proteins and Lipids. Preparations of Buffers, laboratory solutions and pH determination. Enzyme and DNA isolation, extraction, analysis and study of various parameters. Estimation of metal ions and glucose in biological fluids.

Recommended Books

1. Nelson, D. L. (2012). *Lehninger's principles of biochemistry* (6th ed.). Macmillan Higher Education; W. H. Freeman. ISBN: 9781429222631
2. Voet, D., & Voet, J. G. (2011). *Biochemistry* (4th ed., illustrated). John Wiley & Sons Canada. ISBN: 9780470917459
3. Murray, R. K., & Harper, H. A. (2021). *Harper's biochemistry* (29th ed.). Appleton & Lange. ISBN: 9780838536841
4. Zubay, G. L. (2008). *Biochemistry* (4th ed., illustrated). [Publisher not listed]. ISBN: 9780697219008

5. Harvey, R. A., Ferrier, D. R., & Karandish, S. (2010). *Lippincott's illustrated reviews: Biochemistry* (5th ed.) and *Biochemistry map (MedMaps) bundle*. Lippincott Williams & Wilkins. ISBN: 9781451116311
6. Current Literature and Review

Natural Science

MAT-1115 or PHY-1118

MAT-1115 Mathematics for Chemists with MATLAB CrHr: 3(2-1)

Course objectives

Upon successful completion, students will be able to:

1. Apply mathematical techniques to chemical problems involving kinetics, equilibrium, thermodynamics, and spectroscopy.
2. Use MATLAB to perform symbolic and numerical calculations, data visualization, and modeling of chemical systems.
3. Develop confidence in applying computational tools in research and industrial problem-solving settings.

Course Contents

Introduction: Role of Mathematics in Chemistry, Functions and Graphs; Units and Dimensions. Algebra: Linear and Quadratic Equations, Exponential and Logarithmic Functions, Matrices and Determinants, Differential Calculus: Derivatives and Rules. Applications of Derivatives in Thermodynamics. Integral Calculus and Applications, First-order ODEs: Chemical Kinetics, Multivariable Functions and Partial Derivatives, Linear Algebra in Chemical Systems, Numerical Methods: Interpolation, Root-Finding, Error Analysis and Least Squares Method.

Lab:

MATLAB basics: interface, variables, arrays. Plotting functions, units conversion. Solving algebraic equations in MATLAB. Applications in chemical kinetics and pH calculations. Matrix operations and solving linear systems. Reaction rate calculations using symbolic math. Finding maxima/minima, tangent slopes. Integrating rate laws, areas under curves. Solving ODEs numerically (e.g., rate laws). Thermodynamic functions: $\partial H/\partial T$, $\partial G/\partial P$. Eigenvalues in spectroscopy, equilibrium calculations. `fzero`, `interp1`, curve fitting. Data fitting and experimental error analysis. Present chemical modeling simulations using MATLAB.

Recommended Books

1. Mathematics for Physical Chemistry, R.G. Mortimer
2. Applied Mathematics for Physical Chemistry, J.R. Barrante
3. MATLAB for Engineers, Holly Moore
4. Chemical Applications of Group Theory, F.A. Cotton (for matrix applications)

PHY-1118**Fundamentals of Physics****CrHr: 3 (2-1)**

Contents: Electric Charges, Coulomb's Law, Gauss's Law and Applications. Electrical Potential, Equipotential Surfaces, Potential Gradient, Capacitors, Effect of a Dielectric, Polarization, Current, Resistance, Electromotive Force, Resistors in Series and Parallel, Kirchhoff's Rules, Magnetic Field and Flux, Motion of Charged Particles in Magnetic Fields, Thomson's Measurement of e/m , The Biot-Sarvart Law, Magnetic Field of a Long Straight Conductor and Circular Loop, Ampere's Law and Applications, Electromotive Force, Faraday's Law, Induced Electric Fields, Lenz's Law. First Law of Thermodynamics, Energy and Work in Thermodynamics. Adiabatic, Isochoric, Isothermal, Isobaric and Cyclic Processes, Differential Form of the First Law of Thermodynamics, Internal Energy of an Ideal Gas and Heat capacities, Adiabatic Process of an Ideal Gas, Second Law of Thermodynamics, Heat Engines, The Refrigerator, The Carnot Cycle, theorem and working process of Carnot cycle, The Kelvin Temperature Scale, Absolute Zero, Entropy and the Second Law of Thermodynamics, Kinetic Theory of Gases.

Recommended Books:

1. H. C. Ohanian and J. T. Market, Physics for Engineers and Scientists, 3rd Edition, W. W. Norton & Company, 2006.
2. F. W. Sears, M. W. Zemansky and H. D. Young, University Physics, 3th Edition, 1963.
3. R. A. Serway and J. W. Jewett, Principles of Physics, 5th Edition, Brooks Cole, 2012.
4. R. D. Knight, Physics for Scientists and Engineers, 2nd Edition, Addison-Wesley, 2007.

Lab

8-10 Experiments from the list given below.

LIST OF EXPERIMENTS:

- 1(a) To determine an unknown resistance by using neon flash lamp and capacitor.
- 1(b) To determine the unknown high resistance by neon flash lamp and the capacitor.
- 2(a) Conversion of a galvanometer in to ammeter of range 0 to 0.1 A.
- 2(b) Conversion of a galvanometer in to voltmeter of range 0 to 3 V.
- 3 Study the characteristics of photo emission and determination of Plank's constant using a photo cell.

- 4(a) Calibration of an ammeter by potentiometer.
- 4(b) To calibrate a voltmeter by a potentiometer.
- 5 To determine the current sensitivity and charge sensitivity of moving coil galvanometer.
- 6 To compare the capacitances of two capacitors by a ballistic galvanometer.
- 7(a) To plot B-H curve by the deflection magnetometer method and measure the magnetic parameters.
- 7(b) To plot B-H curve on oscilloscope and measure the magnetic parameters.
- 8 To determine the unknown resistance by using Carey Foster's bridge.
- 9 To study the characteristics of acceptor circuit (RLC series circuit).
- 10 To study the characteristics of rejector circuit (LCR series circuit).
- 11 Study of parameter of wave i.e. amplitude, phase and time period of a complex signal by

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- 12 Measurement of self/mutual inductance of transformer winding.
- 13 To study the application of Lorentz force by cathode ray oscilloscope (e/m by J. J. Thomson method).
- 14 Determination of the temperature co-efficient of resistance of a given wire.
- 15 Harmonic oscillations of helical springs-parallel and series connections of spring.
- 16 Measuring moment of inertia of different bodies disk, hollow and solid cylinder.