

Kerala University of Fisheries and Ocean Studies



SYLLABUS AND PATTERN OF QUESTIONS FOR ENTRANCE EXAMINATION - 2019

Note:

1. Duration of the Entrance Test will be 2.00 hours.
2. Answer all 100 questions.
3. Each question carries 4 marks. There shall be a negative mark of one each for wrong answer.
4. Candidate has to **choose the appropriate test code** and indicate in the application form/hall ticket.

Courses with Entrance Exam Subject Code

No.	Courses		Test Code
1	M.F.Sc.		19011
	M.Sc.		
2	a.	Physical Oceanography	19021
3	b.	Earth Sciences	19021
4	c.	Remote Sensing and GIS	19021
5	d.	Disaster Management	19021
6	e.	Climate Science	19021
7	f.	Marine Biology	19031
8	g.	Statistics	19041
9	h.	Biotechnology	19051
			19061
			19062
			19063
			19064
10	i.	Food Science and Technology*	19065
			19061
			19062
			19063
11	j.	Marine Microbiology*	19064
12	k.	Marine Chemistry	19071
			19061
			19062
			19063
			19064
			19065
13	l	Environmental Sciences*	

	M.Tech.		
14	a.	Integrated Coastal Zone Management	19081
15	b.	Ocean and Coastal Safety Engineering	19081
16	c.	Coastal and Harbour Engineering	19081
17	d.	Fisheries Engineering	19081
	LLM		
18	a.	Maritime Law	19091

*For M.Sc. Food Science and Technology, M.Sc. Marine Microbiology and M.Sc. Environmental Sciences the following options are available based on the basic qualifications of the candidates.

Course	Basic Qualifications	Test Code
M.Sc. Food Science and Technology	B.F.Sc.	19011
	B.Sc. (Aquaculture/Fisheries Science)	19011
	B.Sc. (Biotechnology)	19051
M.Sc. Marine Microbiology	B.Sc. (Biochemistry)	19061
	B.V.Sc	19062
	B.Sc. (Zoology)	19062
M.Sc. Environmental Sciences	B.Sc. (Agriculture/ Horticulture/other allied agricultural sciences)	19063
	B.Sc. (Botany)	19063
	B.Sc. (Microbiology)	19064
	B.Sc Food science and /or technology)	19065
	B.Sc (Food Engineering)	
	B.Sc. (Dairy Science)	
	B.Sc. (Chemistry)	19071

Test Code 19011: M.F.Sc. (All Disciplines)

B.F.Sc. Level subjects: Aquaculture, Fishery Resource Management, Fish Processing Technology, Fishery Hydrography, Fisheries Economics, Fisheries Statistics.

Pattern of Question Paper

Sl. No.	Syllabus Areas	No. of Questions	Max. Marks
1.	Aquaculture	25	100
2.	Fishery Resource Management	25	100
3.	Fish Processing Technology	25	100
4.	Fishery Hydrography	10	40
5.	Fisheries Economics	5	20
6.	Fisheries Statistics	5	20
7.	Finance Marketing Management and Co-operation and Fisheries Extension	5	20
	Total :	100	400

Test Code 19021: for

**M.Sc., Physical Oceanography,
M.Sc., Earth Sciences,
M.Sc., Remote Sensing & GIS,
M.Sc., Disaster Management,
M.Sc., Climate Science.**

I. MATHEMATICS

Sets and their representation; Union, intersection and complement of sets and their algebraic properties; Power set; Relation, Types of relations, equivalence relations, functions;. One-one, into and onto functions, composition of functions.

Matrices, algebra of matrices, types of matrices, determinants and matrices of order two and three. Properties of determinants, evaluation of determinants, area of triangles using determinants. Adjoint and evaluation of inverse of a square matrix using determinants and elementary transformations, Test of consistency and solution of simultaneous linear equations in two or three variables using determinants and matrices.

Fundamental principle of counting, permutation as an arrangement and combination as selection, Meaning of $P(n,r)$ and $C(n,r)$, simple applications.

Binomial theorem for a positive integral index, general term and middle term, properties of Binomial coefficients and simple application Arithmetic and Geometric progressions, insertion of arithmetic, geometric means between two given numbers.

Integral as an anti derivative. Fundamental integrals involving algebraic, trigonometric, exponential and logarithmic functions. Integration by substitution, by parts and by partial fractions. Integration using trigonometric identities. Integral as limit of a sum. Fundamental Theorem of Calculus. Properties of definite integrals.

II. PHYSICS

Physics, technology and society, S I units, Fundamental and derived units. Least count, accuracy and precision of measuring instruments, Errors in measurement, Dimensions of Physical quantities, dimensional analysis and its applications.

Force and Inertia, Newton's First Law of motion; Momentum, Newton's Second Law of motion; Impulse; Newton's Third Law of motion. Law of conservation of linear momentum and its applications, Equilibrium of concurrent forces. Static and Kinetic friction, laws of friction, rolling friction. Dynamics of uniform circular motion: Centripetal force and its applications.

Work done by a constant force and a variable force; kinetic and potential energies, work energy theorem, power. Potential energy of a spring, conservation of mechanical energy, conservative and nonconservative forces; Elastic and inelastic collisions in one and two dimensions.

The universal law of gravitation. Acceleration due to gravity and its variation with altitude and depth. Kepler's laws of planetary motion. Gravitational potential energy; gravitational potential. Escape velocity. Orbital velocity of a satellite. Geo-stationary satellites.

Elastic behaviour, Stress-strain relationship, Hooke's Law, Young's modulus, bulk modulus, modulus of rigidity. Pressure due to a fluid column; Pascal's law and its applications. Viscosity, Stokes' law, terminal velocity, streamline and turbulent flow, Reynolds number. Bernoulli's principle and its applications. Surface energy and surface tension, angle of contact, application of surface tension - drops, bubbles and capillary rise. Heat, temperature, thermal expansion; specific heat capacity, calorimetry; change of state, latent heat. Heat transfer conduction, convection and radiation, Newton's law of cooling.

Thermal equilibrium, zeroth law of thermodynamics, concept of temperature. Heat, work and internal energy. First law of thermodynamics. Second law of thermodynamics: reversible and irreversible processes. Carnot engine and its efficiency. Electromagnetic induction; Faraday's law, induced emf and current; Lenz's Law, Eddy currents. Self and mutual inductance.

Alternating currents, peak and rms value of alternating current/ voltage; reactance and impedance; LCR series circuit, resonance; Quality factor, power in AC circuits, wattless current. AC generator and transformer. Electromagnetic waves and their characteristics.

III. CHEMISTRY

Matter and its nature, Dalton's atomic theory; Concept of atom, molecule, element and compound; Physical quantities and their measurements in Chemistry, precision and accuracy, significant figures, S.I. Units, dimensional analysis; Laws of chemical combination; Atomic and molecular masses, mole concept, molar mass, percentage composition, empirical and molecular formulae; Chemical equations and stoichiometry. Classification of matter into solid, liquid and gaseous states.

Measurable properties of gases; Gas laws - Boyle's law, Charles's law, Graham's law of diffusion, Avogadro's law, Dalton's law of partial pressure; Concept of Absolute scale of temperature; Ideal gas equation; Kinetic theory of gases (only postulates); Concept of average, root mean square and most probable velocities; Real gases, deviation from Ideal behaviour, compressibility factor and van der Waals equation.

Thomson and Rutherford atomic models and their limitations; Nature of electromagnetic radiation, photoelectric effect; Spectrum of hydrogen atom, Bohr model of hydrogen atom - its postulates, derivation of the relations for energy of the electron and radii of the different orbits, limitations of Bohr's model; Dual nature of matter, de-Broglie's relationship,

Kossel - Lewis approach to chemical bond formation, concept of ionic and covalent bonds. Ionic Bonding: Formation of ionic bonds, factors affecting the formation of ionic bonds; calculation of lattice enthalpy. Covalent Bonding: Molecular Orbital Theory - Its important features, LCAOs, types of molecular orbitals (bonding, antibonding), sigma and pi-bonds, molecular orbital electronic configurations of homonuclear diatomic molecules, concept of bond order, bond length and bond energy.

First law of thermodynamics - Concept of work, heat internal energy and enthalpy, heat capacity, molar heat capacity; Hess's law of constant heat summation; Enthalpies of bond dissociation, combustion, formation, atomization, sublimation, phase transition, hydration, ionization and solution. Second law of thermodynamics; Spontaneity of processes; ΔS of the universe and ΔG of the system as criteria for spontaneity, ΔG° (Standard Gibbs energy change) and equilibrium constant.

Electrochemical cells - Electrolytic and Galvanic cells, different types of electrodes, electrode potentials including standard electrode potential, half - cell and cell reactions, emf of a Galvanic cell and its measurement; Nernst equation and its applications; Relationship between cell potential and Gibbs' energy change; Dry cell and lead accumulator; Fuel cells.

Absorption- Physisorption and chemisorption and their characteristics, factors affecting absorption of gases on solids - Freundlich and Langmuir absorption isotherms, absorption from solutions. Colloidal state - distinction among true solutions, colloids and suspensions, classification of colloids - lyophilic, lyophobic; multi molecular, macromolecular and associated colloids (micelles), preparation and properties of colloids - Tyndall effect, Brownian movement, electrophoresis, dialysis, coagulation and flocculation; Emulsions and their characteristics.

IV. GEOLOGY

Earth Systems Science: Definitions and Scope. Elementary information on solar system, members of the solar system, terrestrial and Jovian planets. Origin of the solar system, nebular hypothesis, formation of planets. Earth's materials, minerals and rocks. Broad groups of minerals, oxides, sulphides, carbonates, sulphates and phosphates, silicates. Rocks as mineral assemblages, fabric, texture. Igneous rocks, acid, intermediate, mafic and ultramafic rocks. Sedimentary rocks, clastic and non-clastic. Metamorphic rocks, foliated, nonfoliated. Common rocks – granite, granodiorite, pegmatite, rhyolite, syenite, trachyte, diorite, andesite, gabbro, dolerite, basalt, peridotite; conglomerate, sandstone, shale, limestone, slate, phyllite, schist, gneiss, quartzite, marble.

Structure of geologic bodies. Extrusive and intrusive igneous rock bodies, lava flows, sills, dykes, batholiths. Bed and stratum, dip and strike. Folds, antiform, synform, anticline, syncline. Fractures, joints and faults. Foliation, lineation. Unconformity.

Earth's surface processes. Weathering, erosion, mass wasting; bed rock, regolith, soil, soil profile. Erosion, transportation and deposition by wind, river, glacier, groundwater and ocean.

Common landforms related to action of wind, river, glacier; coastal landform. Ice ages, evidence and causes. Oceanic and atmospheric circulation patterns.

Elementary idea of theory of plate tectonics. Lithosphere, asthenosphere. Plates and plate boundaries, relative motion of plates. Present day configuration of plates. Earth's internal processes, magmatism, metamorphism, deformation. Volcanoes and volcanism, products of volcanic eruption, eruptive styles, volcanic belts, recent volcanism in India.

Mineralogy

Scope and definitions; Physical properties of minerals: form and structure, colour and transparency, lustre, streak, specific gravity, hardness, cleavage, fracture, para-, dia- and ferromagnetic properties, radioactivity. Classification of minerals on the basis of chemical composition.

Petrology

Concept of system, component, phase; different types of system; intensive and extensive variables; rocks as systems. Elementary thermodynamics: concept of enthalpy, entropy, molar volume, Gibbs free energy, chemical potential, fugacity and activity. Concept of chemical equilibrium and equilibrium constant; pressure-temperature dependence of Gibbs free energy; relation between Gibbs free energy and equilibrium constant K . Phase rule and its derivation; mineralogical phase rule; degrees of freedom, invariant, univariant and bivariant equilibrium condition; cryoscopic relationship; concept of the liquidus; one-, two- and three-component systems.

Structural Geology

Geometric, kinematic and dynamic analysis of structures. Penetrative and non-penetrative structural elements: primary and secondary planar and linear structural elements, strike and dip, pitch and plunge, representation of planes and lines in stereographic and equal area projection diagrams. Outcrops of planes on horizontal and uneven surfaces: outlier and inlier. Scales of observation of structures. Folds, parts of a fold, antiform, synform, neutral fold, anticline, syncline, nomenclature of folds based on fold shape and orientation of axis and axial plane. Relation between major folds and minor folds.

Sedimentology

Sediment genesis to diagenesis: processes of sediment generation to formation of sedimentary rocks; Weathering, erosion, transportation, deposition and diagenesis. Texture: primary and secondary; Textural components: framework, matrix, cement, allochemical and orthochemical components; Textural parameters: grain size, shape and their statistics; Surface texture; Fabric: orientation, packing; Porosity and permeability.

Economic Geology

Economic Geology and its principal contents; definitions of the terms: protore, ore, gangue, tenor, hypogene and supergene ore deposits, epigenetic and syngenetic mineral deposits; mineral beneficiation; common morphologies of mineral deposits.

An introduction to the following ore forming processes: magmatic crystallization-differentiation and magma immiscibility, precipitation from hydrothermal solutions, sedimentation-diagenesis, ore forming processes on metamorphism and supergene transformation of protore; placer deposits: their distribution and origin.

Pattern of Question Paper:

Sl.No	Syllabus Areas	No. of Questions	Max. Marks
1	PART A: Mathematics *	30 Questions	4 x 30 = 120
2	PART B: Physics	35 Questions	4 x 35 = 140
3	PART C: Chemistry	35 Questions	4 x 35 = 140
4	PART D : Geology**	30 Questions	4 x 30 = 120
	Total questions to be attempted	100	400

Important Note:

Students with Mathematics* need to attempt Serial Nos. 1 to 3 whereas students with Geology** need to attempt Serial Nos. 2 to 4.

Test Code 19031:

M.Sc. (Marine Biology)

Degree Level Subjects: Zoology, Botany, Cell Biology, Genetics, Biotechnology Embryology, Physiology, Evolution, Biochemistry, Biodiversity, Ecology Microbiology, Aquaculture and Fisheries.

ZOOLOGY: General Zoology

BOTANY: General Botany

CELL BIOLOGY: Introduction, tools and techniques, cell and cellular inclusions, protoplasm, chromosomes, cell division.

GENETICS and BIOTECHNOLOGY: Introduction, interaction of genes, gene and gene action, Mendelian principles, Concept of gene, linkage and crossing over, sex linkage, sex limited and sex influenced characters, Gene mapping methods, Extra chromosomal inheritance, Microbial genetics: Methods of genetic transfers-transformation, conjugation, transduction, mapping genes by interrupted mating, fine structure analysis of genes, Human genetics, Mutation, Structural and numerical alterations of chromosomes, Genetic engineering, recombinant DNA technology, applications of biotechnology.

EMBRYOLOGY: Basic concepts of development, Gametogenesis, Oogenesis, fertilization and early development, Morphogenesis and organogenesis in animals and plants, Programmed cell death, aging and senescence.

PHYSIOLOGY: Plan – Photosynthesis – Respiration and photorespiration, Nitrogen metabolism, Plant hormones, Sensory photobiology, Solute transport and photo assimilate translocation, Secondary metabolites, Stress physiology. Animal – Blood and circulation, Cardiovascular system, Respiratory system, Nervous system, Sense organs, Excretory system, Thermoregulation, Stress and adaptation, Digestive system, Endocrinology and reproduction.

BIOCHEMISTRY: Structure of atoms, molecules and chemical bonds. Composition, structure and function of bio-molecules. Bio-energetics, glycolysis, enzymes and enzyme kinetics, proteins and nucleic acids. Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins.

BIODIVERSITY: Principles and methods of taxonomy: Concepts of species and hierarchical taxa, biological nomenclature, classical and quantitative methods of taxonomy of plants, animals and microorganisms. Levels of structural organization: Unicellular, colonial and multicellular forms. Levels of organization of tissues, organs and systems. Comparative anatomy, adaptive radiation, adaptive modifications. Outline classification of plants, animals and microorganisms: Important criteria used for classification in each taxon. Classification of plants, animals and microorganisms. Evolutionary relationships among taxa. Organisms of conservation concern: Rare, endangered and threatened species.

ECOLOGY: Environment, Habitat and Niche, Concept of habitat and niche; niche width and overlap; fundamental and realized niche. Population Ecology, Species Interactions, Community Ecology, Ecological Succession, Ecosystem structure; ecosystem function; energy flow and mineral cycling, primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (fresh, grassland) and aquatic (fresh water, marine, estuarine). Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India. Applied Ecology: Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. Conservation Biology: Principles of conservation, major approaches to management. Conservation strategies and sustainable utilization.

EVOLUTION AND BEHAVIOUR: Lamarck Darwin – concepts of variation, adaptation and natural selection; Mendelism, Origin of cells and unicellular evolution: Origin of basic biological molecules, Evolution of prokaryotes; Origin of eukaryotic cells, Paleontology and Evolutionary History, Origins of unicellular and multi cellular organisms; Major groups of plants and animals, Stages in primate evolution. Population genetics, migration and random genetic drift; Adaptive radiation, isolating mechanisms, Convergent evolution, Sexual selection; Co-evolution, Approaches and methods in study of behaviour, Biological clocks; Development of behaviour; Social communication; Social dominance; Use of space and territoriality; Mating systems, Parental investment and Reproductive success; Parental care; Aggressive behaviour: Habitat selection and optimality in foraging; Migration, orientation and navigation; Domestication and behavioural changes.

MICROBIOLOGY: General classification and taxonomy of microorganisms. Distribution of microorganisms, growth and life cycle, nutrient cycles, microbial degradation, pathogenic microbes, immunology, applied microbiology.

AQUACULTURE: History, definition, scope and significance of aquaculture, Aquaculture – Global and Indian Scenario. Different aquaculture systems. General characters and biology of cultivable finfishes and shell fishes. Criteria for the selection of species, common cultured species.

FISHERIES: Freshwater, Brackishwater and Marine fisheries. Aquatic resources, commercially important fishes and shellfishes of India. Fisheries management and conservation, anthropogenic activities and their effect on fisheries, threatened fish species of India, measures for management and conservation. Pollution and its impacts on aquatic ecosystems and fishery resources.

Pattern of the Question Paper:

Sl. No.	Syllabus Area	No. of Questions	Marks
1.	Cell Biology	10	40
2.	Genetics and Biotechnology	10	40
3.	Embryology	5	20
4.	Physiology	10	40
5.	Biochemistry	10	40
6.	Biodiversity	10	40
7.	Ecology	15	60
8.	Evolution and Behaviour	15	60
9.	Microbiology	5	20
10.	Aquaculture	5	20
11.	Fisheries	5	20
	Total :	100	400

Test Code 19041: M.Sc. (Statistics)

Part A – MATHEMATICS

UNIT – 1

Real and complex numbers, de Moivre's theorem and its applications, Elements of set theory – De Morgan's laws, Matrices: operations on matrices, rank of a matrix, determinants, inverse of a matrix, orthogonality, solution of a linear equations, characteristic roots and vectors, Cayley-Hamilton Theorem, vector space, linear independence.

UNIT - II

Permutations and Combinations, Binomial theorem. Sequences and series: convergence of infinite sequences and infinite series – tests for convergence, absolute convergence. Co-ordinate geometry in two dimensions – line, circle, parabola, ellipse and hyperbola, curvature, asymptotes, tracing of curves.

UNIT – III

Differential calculus: limits, differentiation of function of a single variable; mean-value theorem; maxima and minima; Taylor's and Maclaurin's theorems; function of two or more independent variables, partial differentiation, homogeneous functions and Euler's theorem, composite functions, total derivatives, derivative of an implicit function, change of variables, Jacobians.

UNIT – IV

Integral Calculus: Integration by simple methods, standard forms, simple definite integrals, double integrals, change of order of integration, Gamma and Beta functions, application of double integrals to find area. Calculus of finite differences, interpolation, numerical differentiation and integration, difference equations, Trapezoidal rule, Simpson's rules, solution of simple non-linear equations by numerical methods.

UNIT – V

Ordinary differential equations: differential equations of first order, Exact and Bernoulli's differential equations, equations reducible to exact form by integrating factors, equations of first order and higher degree, Clairaut's equation, methods of finding complementary functions and particular integrals. Concept of Analytic functions: Cauchy-Riemann equations.

Part B - STATISTICS

UNIT – I

Statistics – origin, definition, use and limitations, methods of collecting and editing of data, designing of Questionnaire, classification and tabulation of data, frequency distribution and

curves; diagrams and graphs, measures of central tendency, measures of dispersion – absolute and relative, moments, measures of skewness and kurtosis.

UNIT – II

Probability – definitions and concepts, law of addition and multiplication, conditional probability, Bayes’ theorem; random variables – discrete and continuous, probability mass function, probability density function and distribution function; bivariate distribution, joint, marginal and conditional distributions, independence of random variables; expectation of a random variable, moment generating function and characteristic function, conditional expectation. Standard theoretical distributions (discrete and continuous) and their properties, chebyshev’s inequality, convergence in probability, weak law of large numbers, Lindberg-Levy form of central limit theorem.

UNIT – III

Basic concepts of sampling and Sampling distributions, parameter, statistic and standard error; t, F and chi-square distributions. Statistical Inference: Concept of estimation, point and interval estimation, properties of estimators, methods of estimation, Cramer Rao inequality. Testing of hypothesis – basic concepts, large and small sample tests, tests based on Z, t, F and chi-square distributions, correlation and regression and associated tests of significance, Analysis of Variance (one way and two way).

UNIT – IV

Experimental Designs: Principles of experimentation, CRD RBD and LSD. Sampling Designs: simple random sampling, stratified sampling and systematic sampling. Index numbers: definition, type, construction and tests of index numbers, cost of living index numbers. Time series: components of time series, additive and multiplicative models, measurement of trend and seasonal fluctuations.

Part C – COMPUTER FUNDAMENTALS

UNIT – I

Evolution of computer, computer generations, number systems, converting from one number system to another, binary arithmetics, Boolean algebra and logic gates. Basic anatomy of computers. Operating systems – DOS and Windows. Applications – MS Word, MS Excel, MS Power Point and MS Access.

UNIT – II

Types of software, introduction to higher level languages: compilers, assemblers, interpreters, stages in development of software: flow charts and algorithms. Application packages – data

analysis using statistical packages. Computer networks, network types, communication protocols, internet, world wide web, web browsing and electronic mail.

Pattern of the Question Paper

Sl. No.	Syllabus Area	No. of Questions	Marks
1.	PART A: Mathematics (5 Units)	10 questions from each unit (5x10=50 questions)	4 x 50 = 200
2.	PART B: Statistics (4 Units)	10 questions from each unit (4x10=40 questions)	4 x 40 = 160
3.	PART C: Computer Fundamentals (2 Units)	5 questions from each unit (2x5=10 questions)	4 x 10 = 40
	Total :	100	400

Test Code 19051: M.Sc. (Biotechnology)

Test comprises of 100 questions.

Unit 1: Bio-Organic Chemistry & Bio-molecules- Functional groups and their significance, Inter and intramolecular interactions in biological systems-covalent, hydrogen, hydrophobic, disulphide, peptide, glycosidic and phosphodiester linkages. Classification, Chemical and Physical properties, structure and functions of Carbohydrates, Lipids, Nucleic acids, Proteins, Vitamins & hormones.

Unit 2: Cell Biology- Cell organelles and Functions. Models of membrane structure, transport across membranes, exocytosis, endocytosis, passive transport, active transport, and ion channels. Cell division- phases of cell division, mitosis, meiosis. Cellular interactions- extracellular matrix, cell-cell interaction, cell-matrix interaction and cell adhesion molecules.

Unit 3: Enzymology- Nomenclature and classification, factors affecting enzyme reaction, enzyme inhibition, allosteric enzymes, regulation of allosteric enzymes, zymogens, isozymes, ribozymes, abzymes.

Unit 4: Bioenergetics and Metabolism- Biological oxidation, redox potential, energy rich compounds. Sequence of reaction and regulation of carbohydrate metabolism - glycolysis, gluconeogenesis, Pentose phosphate pathway, glycogen metabolism, TCA cycle, electron transport chain and oxidative phosphorylation. Lipid metabolism – oxidation of fatty acids (alpha, beta and omega), biosynthesis of fatty acids, triglycerides, phospholipids and cholesterol. Amino acid metabolism- transamination, deamination, decarboxylation, urea cycle, glycogenic and ketogenic amino acids, nitrogen balance Disorders related to metabolism.

Unit 5: Genetics- Mendelian laws of inheritance, gene, allele, genotype, phenotype, genome; wild type and mutant type, test cross, back cross and reciprocal cross. Gene interaction- Allelic, incomplete dominance, lethal and co-dominance, non- allelic, complementary gene action .Co-epistasis, dominant and recessive polygenic action ,pleiotropism .Multiple alleles, ABO Blood group system, Rh group and its inheritance. Linked genes, linkage groups, crossing over and recombination, mechanism, kinds and factors affecting crossing over and its significance. Chromosome mapping. Sex linked inheritance of man- colour blindness and hemophilia, incompletely sex linked genes, holandric genes. Cytoplasmic inheritance: Mitochondrial DNA. Sex Determination-chromosomal mechanism of sex determination, sex determination in man, role of Y chromosome, Barr bodies, dosage compensation and Lyon hypothesis. Human Genetics: Karyotyping, normal chromosome complement, pedigree analysis, chromosomal anomalies in man.

Unit 6: Molecular Biology and Recombinant DNA Technology - Genome organization, DNA replication, DNA repair mechanisms, transcription, post transcriptional modification, translation, post translational modification, gene regulation. Types of vectors- plasmids, cosmids,

bacteriophage, YAC, Restriction enzymes, nucleic acid hybridization, DNA cloning- DNA libraries, viruses, DNA sequencing, PCR. Applications of Recombinant DNA technology.

Unit 7: Immunology-Types of immunity- innate and adaptive, Organs and cells involved, antigens, antigen presenting cells, clonal selection, primary and secondary immune response, complement system, haptens, MHC, classification, structure and functions of immunoglobulins, monoclonal antibodies. Autoimmune disorders. Techniques bases on antibodies- RIA, ELISA, immunofluorescence and western blotting.

Unit 8: Microbiology- Classification of microorganisms-bacteria, fungi, protozoa. Microbial species, microbial cell structure, classical experiments in microbiology, Culture media- types and uses, Bacterial Growth curve, factors affecting growth of microbes. Pure culture Methods. Role of microbes in agriculture- nitrogen fixation, bio fertilizers. Antimicrobial agents, drug resistance, transformation, transduction and conjugation. Industrial applications of microbes. Concepts in sterilization, staining techniques, microbes in extreme conditions, pathogenic microorganisms. Environmental Microbiology- Biogeochemical cycles. Viruses- Basic concepts, classification and characteristics.

Unit 9: Techniques in Biology- Chromatography-paper, TLC, GLC, HPLC, ion exchange, gel filtration and affinity chromatography. Microscopy-phase contrast, SEM and TEM. Colorimetry and spectrophotometry. Electrophoresis-gel (native & SDS), isoelectric focusing. Centrifugation-density gradient and ultracentrifuge. Radioactivity- Counters used, applications of radioactive isotopes.

Unit 10: Applications of Biotechnology –Tissue culture, plant genetic engineering, genetic modifications, genetically modified food, gene transfer methods in animals, transgenic animals, animal propagation, conservation biology, genetic modification in medicine-gene therapy. Industrial Biotechnology-commercial production of microorganisms, bioconversions, bioremediation, products from microorganisms, bioreactors, fermentation technology and enzyme technology.

Pattern of Question Paper

Syllabus	No. of Questions	Max. Marks
Unit 1	10	40
Unit 2	5	20
Unit 3	5	20
Unit 4	15	60
Unit 5	15	60
Unit 6	15	60
Unit 7	10	40
Unit 8	10	40
Unit 9	5	20
Unit 10	10	40
	100	400

Test Codes:

CODE 19061: Biochemistry

CODE 19062: Animal Science

CODE 19063: Plant Science

CODE 19064: Microbiology

CODE 19065: Food Science

CODE 19061: Biochemistry

Test comprises of 100 questions.

Unit-1: Physical aspects in Biochemistry-Water, pH, pOH, dissociation of weak acids, theories of acids and bases, buffers, biological buffers, Henderson-Hasselbalch equation, diffusion, osmosis, biological significance, osmotic pressure, colloids, Donnan-membrane equilibrium-biological application.

Unit-2: Biomolecules & Enzymology - Classification, physical properties, chemical reactions and functions of Carbohydrates, Lipids, Proteins, Nucleic acids and Vitamins. Enzymology – Classification, nomenclature, enzyme specificity, enzyme units, coenzymes and their functions, ribozymes, abzymes, isozymes, enzyme kinetics, factors affecting velocity of enzyme catalyzed reactions, Michaelis-menton equation, Km, Line weaver-Burk Plot, Enzyme inhibition, Allosteric enzymes and their regulation, Multienzyme complexes, zymogens.

Unit-3: Cell Biology– Structure and function of different cell organelles, Models of plasma membrane, transport across membranes-Facilitated, simple and active, ion channels, Cell division- Cell cycle, phases of cell division, apoptosis and necrosis. Protein trafficking, Cytoskeletal proteins, Cell wall Extracellular matrix- Cell-ECM interaction, cell-cell interaction, cell adhesion molecules.

Unit-4: Physiology and Immunology- Digestion and absorption of carbohydrates, lipids and proteins. Blood- plasma proteins, blood coagulation, hemopoiesis, classification of blood groups. Respiration- chemical and physiological events in gaseous exchange, oxygen transport, partial pressure, saturation kinetics, hill plot, buffers in blood-functions, respiratory and metabolic acidosis and alkalosis. Muscle- structure, sources of energy, muscle proteins, sliding filament theory, muscle contraction, neurotransmitters and neuromodulators, composition of bone. Hormones- site of secretion and function of hormones, Mechanism of action of hormones. Immunology- Types of immunity- innate and adaptive, Organs and cells involved, antigens,

antigen presenting cells, clonal selection, primary and secondary immune response, complement system, haptens, MHC, classification, structure and functions of immunoglobulins, monoclonal antibodies. Autoimmune disorders. Techniques based on antibodies- RIA, ELISA, immunofluorescence and western blotting.

Unit-5: Intermediary Metabolism - Basic design of metabolism, Bioenergetics, Carbohydrate metabolism- Sequence and regulation of - Glycolysis, Gluconeogenesis, pentose phosphate pathway, Glycogen metabolism, Citric acid cycle, electron transport and oxidative phosphorylation. Photosynthesis- Dark and light reactions, cyclic and non-cyclic photophosphorylation, C-4 pathway, photorespiration. Lipid metabolism -Fatty acid oxidation, ketone bodies, Fatty acid synthesis, Biosynthesis of phospholipids, triglycerides and cholesterol, Biosynthesis of membrane lipids. Overview of amino acid metabolism- Catabolism of amino acids, Biosynthesis of amino acids, Precursor functions of amino acids, Biosynthesis of purine and pyrimidine nucleotides, Deoxy ribonucleotides and synthesis of nucleotide triphosphate, Degradation of purine and pyrimidine nucleotides, Integration of metabolism. Metabolic disorders and diseases. Xenobiotic metabolism

Unit-6: Molecular Biology – A historical perspective; Mendel’s classical experiments with pea, Law of Segregation, Law of Independent Assortment; Extensions and modifications of Mendelian genetic analysis – Dominance, Multiple alleles, Rh Factor, Degrees of gene expression; Sex determination in prokaryotes and eukaryotes, Genetic basis of sex determination. Linkage, Crossing-over and chromosome mapping, Human chromosomes – morphology; Karyotyping. Genes and genomic organization, Structural and numerical aberrations involving chromosomes, mutations, agents of mutation, DNA repair mechanisms, DNA replication, transcription in prokaryotes, post transcriptional modifications, transcriptional inhibitors, protein synthesis, post translation modifications, translational inhibitors, gene regulation in prokaryotes-operons. Recombinant DNA technology- vectors, DNA libraries, PCR, DNA finger printing, applications of techniques.

Unit-7: Techniques in Biology - Colorimetry and spectrophotometry, Beer-Lamberts law. Microscopy- compound, electron microscopy, phase contrast microscopy. Chromatography- ion exchange, gel filtration, paper, GLC, HPLC, affinity chromatography. Electrophoresis- paper, gel-native and SDS, isoelectric focusing. Centrifugation-density gradient, ultracentrifugation, Radioactivity- radioactive isotopes, applications in biology.

Pattern of Question Paper

Syllabus	No. of Questions	Max. Marks
Unit 1	10	40
Unit 2	15	60
Unit 3	10	40
Unit 4	15	60
Unit 5	20	80
Unit 6	20	80
Unit 7	10	40
	100	400

CODE 19062: Animal Science

Test comprises of 100 questions.

Principles of Taxonomy and Systematics; History of Animal Taxonomy; Types of Classification; Linnaeus Era: Artificial system of Classification, Natural System of Classification Bentham and Hooker; Phylogenetic System of Classification – Engler and Prantl's, Hutchinson's, Takhtajan System of classification of animals. Types of Classification – Phenetic Classification, Natural Classification, Phylogenetic or Cladistic Classification, Evolutionary Classification, Omniscpective Classification, Taxonomic Hierarchy. The Five Kingdom System. Development of Concepts, Binomial Nomenclature; Important Rules of Nomenclature; Binomial System. Tools of Taxonomist; Keys to identification.

Protozoans; General Characteristics, Structural Organisation and Function; Classification of Protozoa – Flagellated Protozoans, Amoeboid Protozoans, Spore forming Protozoans, Ciliated Protozoans; Parasitic Protozoans- Amoebae, Flagellates, Sporozoans, Ciliates. Levels of Body Organisation; Characteristics of Metazoa; Symmetry – Asymmetrical and Spherical, Radial and Biradial, Bilateral; Development Patterns – Cleavage, Fate of Blastopore; Germ Layers; Body Cavity-Pseudocoelom, Coelom; Cephalisation and Segmentation; Origin and Evolution of Metazoa – Syncytial Theory, Colonial Theory, Polyphyletic Theory.

Phylum Porifera - Sponges, Characteristic features, Classification; Phylum Cnidaria- Characteristic features, Classification, Coral Reefs; Phylum Ctenophora – Characteristic features, Classification; Phylum – Platyhelminthes – Characteristic features, Classification. Pseudocoelomata: Phylum Nematoda – Characteristic features, Classification; Phylum Rotifera – Characteristic features, Classification. Coelomata: Eucoelomata: Phylum Annelida, Coelom, Metamerism, Characteristic features, Classification; Phylum Arthropoda –Trilobitomorpha, Chelicerata, Crustacea, Uniramia; Phylum Onychophora; Phylum Mollusca –Monoplacophora, Polyplacophora, Aplacophora, Gastropoda, Bivalvia, Scaphopoda, Cephalopoda; Phylum Echinodermata – Asteroidea, Ophiuroidea, Echinoidea, Holothuriodea, Crinoidea.

Phylum Hemichordata–Basic Adaptive Features, Affinities; Phylum Chordata: General Characters, Classification, Basic Adaptive Features, Affinities; Ancestry and Evolutionary Trends. Agnatha: General Characters and Classification; Pisces: General Characters and Classification; Some Common Fresh Water Fishes of India; Class Amphibia: Salient Features and General Organisation. Reptiles:Origin and Adaptive Radiation, Changes in Traditional Classification, Classification of Extant Reptiles, Main Characteristics, Distinguishing Features of Reptiles as Compared to Amphibians; Birds: Ancestry and Evolution, Classification, Characteristics, Form and Function, Social Behaviour of Birds. Mammals: General Characters

and Classification; Natural History: Monotremata/Prototheria, Marsupialia, Eutheria, Primates, Economic Importance; Evolution and Affinities; Threatened Species in India.

Skeleton – Exoskeleton, Endoskeleton, Hydroskeleton; Polymorphism – Polymorphism in Cnidaria, Polymorphism in Insecta. Locomotion in Coelenterates, Locomotion in Flatworms, Nematodes, Annelida – Body Musculature, Hydrostatic Skeleton, Locomotor Structures, Mechanics of Locomotion; Arthropoda, Mollusca; Locomotion in Echinodermata. Nutrition in Non-Chordates – Feeding and Digestion in Sponges, Coelenterates, Flatworms, Annelids, Molluscs, Echinoderms, Arthropods; Excretion in Non-Chordates – Protonephridia and Metanephridia, Malpighian Tubules, Coelomoducts of Molluscs; Osmoregulation in Freshwater Non-Chordates and in Marine Non-Chordates, Water Conservation in Terrestrial Non-Chordates.

Respiratory Systems – Respiratory Organs, Process of Respiration, Respiratory Pigments; Circulatory System – Open type and Closed type of Circulatory Systems. Organisation of Nervous System – Nerve Cell, Neuroglia, Ganglia, Nerves; Primitive Nervous System: Nerve Net; Advanced Nervous Systems – Platyhelminthes, Annelids, Arthropods and Molluscs; Giant Nerve Fibre; Information Processing; Receptors – Properties, Mechanoreceptors, Chemoreceptors, Photoreceptors. Endocrine versus Neural Integration; Endocrine Organs – Neurosecretory Cells and the Concept of Neurosecretion, Neurosecretory Systems, Endocrine Organs; Hormones in Growth and Reproduction – Annelida, Mollusca, Arthropoda; Hormones Controlling other Functions. Adaptive Radiations in Annelida, Arthropoda and Mollusca, Flight in Insects; Migration in Insects. Taxis and Kinesis; Biological Rhythms – Control of Biorhythms, Biological Clock; Communication Behaviour – Visual Signals, Mechanical Signals, Chemical Signals, Communication among Honeybees, Dance Language; Courtship Behaviour – Need for Courtship Behaviour, Sex Differences in Courtship Behaviour, Visual, Mechanical and Chemical Displays, Social Organisation in Insects; Parasitism – Types of Parasites, Effects of Parasitism on Parasites. Injurious and Harmful Arthropods – Arachnids of Medical, Veterinary and Agricultural Importance, Insects of Medical, Veterinary and Agricultural Importance, House Hold Insects. Beneficial Nature of Non-Chordates; Phylum Arthropoda and Mollusca as source of food;

CODE 19063: Plant Science

Test comprises of 100 questions.

Classification of Organisms: The Five Kingdoms; Characteristics of Plants; Environmental Degradation and Plant Diversity. Domains of Organisms of Primary and Ancient Lineage; Characteristics, Affinities, Evolution and Classification of Cyanobacteria, Fungi, Algae, Bryophytes, Pteridophytes.

Classification of Algae: Criteria for Classification; Prokaryotic: Division Cyanophyta; Eukaryotic Algae of Divisions Chlorophyta, Phaeophyta, Rhodophyta, Xanthophyta, Chrysophyta, Euglenophyta, Dinophyta, Cryptophyta, Bacillariophyta; Systematic Position of the Genera studied. Algal Habitats and Distribution. Morphology of Algae: Unicellular Forms; Anacystis, Chlamydomonas, Colonial Forms; Microcystis, Volvox, Filamentous Forms: Nostoc, Ulothrix, Oedogonium, Heterotrichous Forms; Draparnaldiopsis, Coleochaete, Ectocarpus, Thalloid Forms: Ulva, Fucus, Polysiphonoid Forms; Polysiphonia; Structure of Prokaryotic and Eukaryotic Algal Cells. Algal Associations; Algal-Plant, Algal-Animal and Algal-Symbiotic Associations. Algae and Human Welfare: A Nutritional Food Source; A Source of Animal Feed Use in Waste Water Treatment and Biofertilisers; A Source of Energy; Industrial Applications: Phycocolloids, Diatomite, Pigments; Medicinal Uses; Algal Companies; Harmful Effects.

Fungal Habitats and Morphology: Habitats; Nutrition and Growth, Morphology; Unicellular Forms -Yeast, Slime Moulds – Cellular and Plasmodial Types, Filamentous Forms, Pseudoparenchymatous Forms; Fungal Diseases: Symptoms, Pathogen, Disease Cycle and Control Measures of Late Blight of Potato: (*Phytophthora infestans*), Powdery Mildew of Rose (*Sphaerotheca pannosa*), Red Rot of Sugarcane (*Colletotrichum falcatum*), Smut of Wheat (*Ustilago tritici*), Wheat Rusts (*Puccinia graminis*), Skin Diseases: Lumpy Wool, Facial Eczema, Sporotrichosis, Ring Worm and Favus. Role of Fungi in Human Welfare.

Morphology and Anatomy of Bryophytes: General Characteristics and Life Cycle; Adaptations to Land Habit; Morphology and Anatomy of Hepaticopsida - *Riccia*, *Marchantia*, *Pellia*, *Anthocerotopsida* -*Anthoceros*; *Bryopsida* - *Sphagnum*, *Funaria*. Reproduction and Evolutionary Trends in Bryophytes: Importance and Uses of Bryophytes: Medicine, Construction, Decorative and Packing Materials, House Hold Uses, Treatment of Waste Water, Mosses as Animal Food and Shelter; Uses of Bryophytes in Horticulture.

Pteridophytes: Comparative Morphology and Anatomy, Pteridophytic Life Cycle; General Characteristics and Relationship with Other Groups; Formation of Fossils and Their Types;

Morphology and Anatomy of Rhynia, Cooksonia, Psilotum, Lycopodium, Selaginella, Equisetum, Pteris, Cyathea, Marsilea; Distribution of Pteridophytes in India.

General Characters of Gymnosperms, Distribution, Morphology, Anatomy, Reproduction, Embryogeny, Polyembryony, Mature Seed and Germination; Classification of Gymnosperms. Economic importance of Gymnosperms. Cycas, Pinus, Ephedra and Gnetum.

General Characters of Angiosperms; Distribution and diversity Angiosperms; Vascular tissue, Reproduction, Dispersal, Plant Defence, Origin and Classification of Angiosperm; Representative, Angiosperms; (Asteraceae, Orchidaceae, Poaceae, Leguminosae); Root, Stem and Leaf –comparative studies, Flower; Transition and Formation of floral organs; Fruits: Simple and Compound Fruits, Pollination; Attractants for Pollinators; Specific Pollinators and Behaviour.

Spices and Condiments; Spices obtained from Underground Parts; Bark; Spices obtained from Flower Buds or Flowers; Spices obtained from Fruits, Seeds. Tea; Coffee; Cocoa. Medicinal Plants; Fumatory and Masticatory Materials Yielding Plants; Oil-Yielding Plants. Commercially Important Timber Yielding Plants; Commercially Important Fibre-Yielding Plants: Cotton, Jute, Coconut.

Study of Dicot Families: Ranunculaceae; Brassicaceae; Malvaceae; Rutaceae; Fabaceae: Mimosoideae, Caesalpinioideae, Papilionoideae; Myrtaceae; Cucurbitaceae; Apiaceae. Rubiaceae; Asteraceae; Sapotaceae; Apocyanaceae; Asclepiadaceae; Solanaceae; Acanthaceae; Lamiaceae; Amaranthaceae; Santalaceae; Euphorbiaceae. Study of Monocot families: Musaceae; Liliaceae; Arecaceae; Poaceae. Variation in Flowers, Variations in Floral parts; Window leaves, Parasitic Plants: Carnivorous Plants, Seeds and Fruits, Some Special Monocots.

CODE 19064: Microbiology

Test comprises of 100 questions.

Viruses, Prokaryotes, and Eukaryotes. General Principles of classification and nomenclature of microorganisms (Haeckel's three kingdom classification and Whittaker's five kingdom classification). General characteristics of viruses, Ultra Structure of bacterial cell, classification of bacteria in brief as per Bergey's Manual of Systematic Bacteriology. Distribution, structure of typical algal cell. General thallus structure and reproduction in algae and fungi. Major nutritional types of microorganisms. Nutritional requirements of microorganisms. Nomenclature, classification, properties of microbial enzymes mode and mechanism of enzyme action, enzyme regulation, inhibition, cofactors and coenzymes. Photosynthetic microorganisms, photosynthetic pigments and apparatus in prokaryotes and eukaryotes. Anaerobic Respiration. Aerobic Respiration Chromosomes: Prokaryotic and eukaryotic organization. Recombination in Bacteria: Transformation, Transduction and Conjugation process – F – factor, Sexduction, Transposons. Structure and types of DNA and RNA. Protein synthesis. Nature and types of mutation. Damage and repair of DNA.

Distribution of microorganisms in the aquatic environment. Water-borne diseases. Biological indicators of water pollution. Determination of sanitary quality of water: SPC, Tests for coliform, MPN, IMVIC reactions, membrane filter technique. Tools involved in genetic engineering: Modifying enzymes. Cloning vehicles. DNA libraries. DNA sequencing. Potential problems of genetic engineering.

Biofertilizers: Nitrogen fixing, Phosphate solubilizing and cellulolytic microbes, mass production of bacterial inoculants (Rhizobium, Azotobacter, Azospirillum, cyanobacteria). Biological control. Biopesticides. Rhizosphere microorganisms.

Plant pathology: classification of plant diseases. Microbial spoilage of food and food preservation techniques. Mycotoxin with reference to Aflatoxin, Staphylococcal intoxication, Botulism, salmonellosis.

Food safety and quality control. Fermented dairy products. Microorganisms of industrial importance. Fermentation media. Design of typical fermentors. Submerged and Solid state fermentation. Downstream processing. Industrial production and its uses of Ethyl alcohol, Wine, Penicillin, Lactic acid, Amylase, Protease.

Bacterial diseases: Tuberculosis, Cholera, Typhoid, Syphilis. Viral diseases: Hepatitis, Poliomyelitis, AIDS. Fungal diseases: Candidiasis, Dermatophytosis (Tinea – ringworm infection). Protozoan diseases: Malaria, Trichomoniasis.

CODE 19065: Food Science

Test comprises of 100 questions.

Food Chemistry: components of foods – moisture, carbohydrates, enzymes, fats, minerals, vitamins, etc – types, characteristics, nutritive value, significance in human health. Structure of plant and animals tissues; changes after harvesting – action of enzymes.

Food Microbiology: characteristics of microorganisms, use of microscope. Organisms associated with foods – bacteria, fungi, yeasts; food spoilage and pathogenic organisms – changes in food caused by microorganisms. Useful microorganisms-fermentation.

Physical Properties of Foods and Engineering : texture, viscosity, conductivity, phase change, fluid dynamics, heat and mass transfer. Equipment for food processing – freezers and cold store, heating equipment, seamer, dryers, evaporators, mixers, filtration equipment, centrifuges, grinders, press, conveyor systems, etc. food processing plant layout.

Food preservation : Principles of various methods of preservation. Chilling –use of ice, chilled air, chilled seawater. Freezing-changes in foods upon freezing and storage-ice crystal formation, methods, changes in food. Preservation using heat-canning, retort pouch packing, etc-methods. Air drying and freeze drying-factors influencing, methods. Salting-salt penetration, methods. Smoking-components of wood smoke, smoked food characteristics. Pickling-effect of acids in preserving foods. Radiation-technique, dosage, precautions, advantages.

Plant and Animal Food Products: cereals, legumes, oil seeds, fruits, vegetables, plantation products (coffee, tea, cocoa), spices, beverages –raw materials characteristics and products – eg. flour, farinaceous products, oil, jam, juice, spice powders, oleoresins, chocolates, soft drinks, etc. methods of production and storage. Meat, poultry, eggs, fish and shellfish, dairy products – raw material characteristics and products-eg. meat based products-loaf, burger, cutlet, etc., poultry and egg products; fish products-coated products, mince products; milk products–milk, yogurt, condensed milk, etc. methods of production and storage.

Food Additives: preservatives/antimicrobial agents, antioxidants, nutritional additives, sweeteners, food colours, binders, emulsifiers, enzymes, firming agents, gelling agents, thickeners, leavening agents, seasonings, flavouring agents and flavor enhancers –influence on foods.

Food Packaging : objectives of packing. Packaging materials and containers-glass, metal (aluminium, tinplate,etc.), paper, paperboard, corrugated fibreboard, plastics (polyethylene,

polypropylene, cellophane, etc.), laminates –properties useful for food packing. Containers- bottle, jar, can, retort pouch, bag, box/carton, etc.

Quality Assurance: Food hazard – microorganisms, pests, toxic substances, etc., Sanitation in food processing plant, personnel hygiene-measures to be taken, sanitizers-detergents, disinfectants. Food quality evaluation – sensory, physical, chemical and microbiological tests. Food safety standards regulatory agencies – Bureau of Indian Standards, AGMARK, FPO, ISO. Concepts of GMP,HACCP. Waste utilization /disposal, pollution control, effluent treatment.

Test Code: 19071 M.Sc., Marine Chemistry

Test comprises of 100 questions.

Unit 1

Atomic structure and chemical bonding: Dual nature of matter – de Broglie equation, Schrodinger wave equation and its applications, Eigen value and eigen function- probability distribution of electron around the nucleus **Periodic properties:** Long form of periodic table- classification as s, p, d and f block elements -periodicity in properties- variation of atomic and ionic radii, electron affinity, ionisation energy and electronegativity along periods and groups: Properties of ionic compounds- Born-Haber cycle- Valence bond theory – hybridization of atomic orbitals and geometry of molecules S and P-Block elements. **Acids, Bases and Non-aqueous solvents** Acids and Bases: Arrhenius theory, acids and bases in protic solvents, Bronsted-Lowry theory, Lewis theory, the solvent system **Coordination Chemistry:** ligands- monodentate, bidentate, and polydentate ligands; coordination sphere; coordination number; nomenclature of mononuclear and dinuclear complexes. Structural and stereoisomerism in tetrahedral, square planar and octahedral complexes. Crystal field theory - splitting of d-orbitals in octahedral and tetrahedral complexes - factors affecting the magnitude of crystal field splitting - effects of crystal field splitting - **Qualitative Analysis:** Applications of solubility product and common ion effect in the precipitation of cations –Iodometric, Iodimetric, precipitation and complexometric titrations – Indicators. Gravimetric analysis: Precipitation methods - Conditions of precipitation – co-precipitation and post precipitation - washing of precipitates, **Noble gases:** Occurrence - isolation of noble gases from the atmosphere, importance of inert gases in theoretical chemistry - chemical properties - xenon chemistry: preparation and properties of fluorides, oxides and oxofluorides of xenon - xenon fluoride complexes - structure and bonding in xenon compounds. hydrates and clathrates of noble gases.

Unit 2

Gaseous state; Types of molecular velocities and their inter relations - mean, rms, most probable velocities - - mean free path – Degrees of freedom of gaseous molecules - heat capacity and molecular basis. Viscosity of gases **Solid state:** Difference between crystalline and amorphous solids - isotropy and anisotropy - crystal lattices - laws of crystallography - elements of symmetry of crystals - crystal systems - Miller Bragg's equation, structure of crystals by X-ray diffraction methods **Surface chemistry:** Adsorption - physisorption and chemisorptions - adsorption of gases by solids - adsorption isotherms - General characteristics of catalytic reactions – phase transfer catalysis - acid base catalysis - enzyme catalysis - Michaelis-Menten equation **Nuclear chemistry:** Natural radioactivity - detection and measurement of radioactivity –Artificial radioactivity - nuclear fission and nuclear fusion – mechanisms – applications - differences – nuclear reactors - hazards of radiations -C¹⁴ dating, rock dating, **Thermodynamics:**

extensive and intensive properties - state functions and path functions - types of processes - Zeroth law of thermodynamics. internal energy and enthalpy, Joule-Thomson effect – Introduction to second law of thermodynamics - spontaneous processes - Entropy: Definition – entropy a state function - Third law of thermodynamics: Nernst heat theorem- **Chemical kinetics**; Rate of reaction-Measuring rates of reaction-expressing reaction rates- factors influencing rate-rate constant-Rate laws, Stoichiometry, order and molecularity of reactions, Effect of temperature on rate constant. The activation energy – **Ionic equilibria**: The Ostwald's dilution law-experimental verification-limitations-acids and bases-Lewis concept-dissociation of weak acids and weak bases-dissociation of water-pH scale-common ion effect- its applications- **Electro chemistry** Definitions of specific, equivalent and molar conductances – Relations between them – measurement of conductance and cell constant. Strong and weak electrolytes. Diffusion and ionic mobility- molar ionic conductance and viscosity- Degree of dissociation of weak electrolytes – Determination of Ionic product of water **Galvanic cells** – Reversible and Irreversible cells – EMF and its measurement – Weston Standard cell – types of reversible single electrodes –Nernst theory for single electrode potential –standard reduction potentials – electro chemical series **Concentration cells** – electrode concentration cells- electrolyte concentration cells- concentration cells with and without transference.

Unit 3

Principles of reactions: Polar effects-inductive, resonance and steric effects, preparation, properties and structures of carbonium ions, carbanions and free radicals -type of reactions - substitution, addition, elimination and polymerisation reactions, **Hydrocarbons** Conformations of ethane and n-butane- mechanism of chlorination of methane. Addition to unsymmetrical olefins S_N1 and S_N2 mechanisms - E_1 and E_2 mechanisms- **Alcohols and ethers** Distinction between primary, secondary and tertiary alcohols, Distinction between ethers and alcohols. **Organometallic compounds and organo sulphur compounds:** Preparation, structure and synthetic uses of Grignard reagent-preparation and reactions preparation and properties of thioalcohols and thioethers – sulphonal-mustard gas and sulphones **Aldehydes and ketones** Structure and reactivity of carbonyl group – relative reactivities of aldehydes and ketones – **Carboxylic acids** Structure of carboxylic acid and carboxylate anion – relative strengths of monocarboxylic acids – effect of substituents on acidity – Hell – Volhard – Zelinsky reaction – **Aliphatic nitrogen compounds:** General methods of preparation of primary, secondary and tertiary amines – General Properties – Isomerism – Stereochemistry –Distinction between primary, Secondary and tertiary amines. **Alicyclic compounds;** - general methods of preparation – spectroscopic properties – chemical properties – relative stabilities of cyclo alkanes – Baeyer's strain theory **Stereochemistry** : Stereoisomerism - definition - classification into optical and geometrical isomerism R-S notations for optical isomers. **Optical isomerism** Optical activity in compounds not containing asymmetric carbon atoms. **Geometrical isomerism** - cis-trans, syn-anti and E-Z notations - **Polynuclear hydrocarbons** Isolated systems Preparation of diphenyl, diphenyl methane, triphenyl methane and stilbene. Condensed systems Synthesis,

reactions, structure and uses of naphthalene. Preparation and reactions of naphthols, naphthylamine and naphthaquinone. **Heterocyclic Compounds**; Preparation, properties and uses of furan, pyrrole & thiophene - aromatic character. Synthesis and reactions of pyridine and piperidine - comparative study of basicity of pyrrole, pyridine and piperidine with amines **Carbohydrates**: Classification-Monosaccharides- constitution of glucose and fructose. Reactions of glucose and fructose – Osazone formation, Mutarotation and its mechanism, Disaccharides- sucrose- reactions and structure. Polysaccharides – starch and cellulose **Phenols** Acidic character of phenols- effect of substituents on acidity of phenols - Mechanisms of Kolbe's reaction and Riemer-Tiemen reaction. **Aldehydes and ketones** Preparation and uses of cinnamaldehyde. Coumarin, vanillin, Michler's ketone, p-benzoquinone-Quinone mono oxime tautomerism. Mechanism of Cannizzaro reaction, benzoin condensation, **Aromatic acids** Ortho effect, preparation of mandelic acid, cinnamic acid and anthranilic acid.

Unit 4

Polymers; Definition - Monomers, Oligomers, Polymers - Classification of polymers-: Natural synthetic, linear, cross linked and network- plastics, elastomers, fibres, Homopolymers and Copolymers, Thermoplastics- Polyethylene, Polypropylene, polystyrene, Polyacrylonitrile, Poly vinyl Chloride, nylon and polyester - Thermosetting plastics -: Phenol formaldehyde and epoxide resin-Elastomers- Natural rubber and synthetic rubber - Buna - N, Buna-S and neoprene. **Fertilizers** : Classification, macronutrients -role of nitrogen, potassium and phosphorus on plant growth – **Pesticides** – Definition- Classification of Pesticides based on the use and chemical composition– examples -general methods of application –Benefits of pesticides-Potential hazards. Safety measures -first aid. **Insecticides** : Plant products – Nicotine, pyrethrin – Inorganic pesticides – borates. Organic pesticides – D.D.T. and BHC. Fungicide : Sulphur compounds, Copper compounds, Bordeaux mixture. **Herbicides** : Acaricides – Rodenticides. Attractants – Repellants. **Food additives and preservatives** Definition - permitted food additives, characteristics and their role: antioxidants, stabilizers, flavours, sweeteners, emulsifiers, thickeners, food colourants. **Food adulterations** Definition - adulterant, adulteration - types of adulterants - common adulterants and their determination in milk, oils, ghee, honey, chilly powder, coriander powder, turmeric powder, coffee powder, tea dust, asafoetida - food poisoning and its prevention **Water pollution**; -sources of water pollution-types of water pollutants: sewage and domestic wastes, industrial effluents, agricultural discharges, detergents, disease causing agents and radioactive materials. **Water analysis**: Sampling and preservation of water samples , physical examination of water : color, odour, turbidity, taste and electrical conductivity – chemical characterisation : pH, acidity, alkalinity, TDS, total, temporary, permanent, calcium and magnesium hardness, chloride, fluoride, BOD, COD **Water purification**: Purification of water for drinking purposes: Sedimentation, filtration and disinfection- Desalination: reverse osmosis-Purification of water for industrial purposes: water softening-permutit process and ion-exchange process. **Wastewater treatment**:

elementary ideas of waste water treatment: pre-treatment-primary treatment-secondary treatment: aerobic and anaerobic processes – tertiary treatment.

Unit 5

Analytical chemistry: Errors and data analysis, deviation, mean deviation, relative mean deviation, standard deviation, coefficient of variation and variance – accuracy and precision – types of errors – random and systematic errors – methods of detection and elimination of systematic errors – student's t-test – confidence levels method of least squares – significant figures and computational rules. **Electroanalytical techniques:** Electrogravimetry : principle, instrumentation and applications. Coulometry : constant current coulometry – coulometric titrations – applications – potentiostatic coulometry – Polarography : principle – advantages and disadvantages of DME: **Spectroanalytical and thermoanalytical methods:** Spectroanalytical methods : principle, instrumentation and applications of colorimetry, spectrophotometry and fluorimetry – light scattering techniques: nephelometry and turbidimetry. principle, instrumentation and applications of TGA and DTA – characteristic features of TGA and DTA curves – factors affecting TGA and DTA curves–**Chromatography:** Classification of

chromatography methods. Column Chromatography – paper chromatography, R_f values, factors affecting R_f values. Experimental procedures, choice of paper and solvent systems, developments of chromatogram. Two dimensional chromatography. Thin layer chromatography: principles, factors affecting R_f values. Experimental procedures. Choice of adsorbents and solvents. Ion exchange chromatography- cation exchange resins, anion exchange resins, ion exchange reactions, ion exchange equilibria properties of ion exchange resins, ion exchange capacity, Techniques- applications. HPLC, Stationary and Mobile phases. . Mobile Phase - Types of HPLC.

Unit 6

Photochemistry; Laws of photochemistry – Beer Lambert law, Grotthus - Draper law, Stark-Einstein law - Quantum efficiency – Jablonski diagram - radiative and non radiative transition - internal conversion, intersystem crossing - qualitative description of fluorescence, phosphorescence - chemiluminescence, bioluminescence, **Spectroscopy:** various types of molecular spectra - electronic, vibrational and rotational energy levels - Born-Oppenheimer approximation. Rotation spectra of diatomic molecules - **UV-visible spectroscopy:** theory - types of transitions in molecules - selection rules for electronic spectra - factors affecting absorption maximum and intensity – applications. **IR spectroscopy :** theory - stretching and bending vibrations - factors affecting vibrational frequencies - important spectral regions for the characterization of functional groups - finger print region - determination of force constant Raman spectroscopy: Principle - Rayleigh and Raman scattering - Stokes and Anti-stokes lines - differences between IR and Raman spectroscopy - **NMR spectroscopy:** Theory of NMR, modes of nuclear spin-relaxation process - shielding effect, hyperfine splitting, coupling constants, -

chemical shift **ESR spectroscopy**: principle - energy level splitting - presentation of ESR spectrum for methyl and benzene radicals, **Nanochemistry** Definition - size dependent properties: magnetic, electrical and optical properties – quantum dots – metal oxides and metal nano particles - ceramic nano particles Synthesis of nanomaterials - bottom-up and top-down approaches - thin film deposition - Fullerenes - carbon nanotubes - single walled and multi walled nano tubes.

Pattern of Question Paper

Sl. No.	Syllabus Areas	No. of Questions	Max. Marks
1.	Unit 1	15	60
2.	Unit 2	20	80
3.	Unit 3	20	80
4.	Unit 4	15	60
5.	Unit 5	15	60
6.	Unit 6	15	60
	Total :	100	400

Test Code 19081: M.Tech.,

**M.Tech., Integrated Coastal Zone Management,
M.Tech., Ocean and Coastal Safety
Engineering, M.Tech., Coastal and harbor
Engineering, M.Tech., Fisheries Engineering.**

I. Mathematics:

Sets and their representation; Union, intersection and complement of sets and their algebraic properties; Power set; Relation, Types of relations, equivalence relations, functions;. One-one, into and onto functions, composition of functions.

Matrices, algebra of matrices, types of matrices, determinants and matrices of order two and three. Properties of determinants, evaluation of determinants, area of triangles using determinants. Adjoint and evaluation of inverse of a square matrix using determinants and elementary transformations, Test of consistency and solution of simultaneous linear equations in two or three variables using determinants and matrices.

Fundamental principle of counting, permutation as an arrangement and combination as selection, Meaning of $P(n,r)$ and $C(n,r)$, simple applications Binomial theorem for a positive integral index, general term and middle term, properties of Binomial coefficients and simple application Arithmetic and Geometric progressions, insertion of arithmetic, geometric means between two given numbers.

Integral as an anti derivative. Fundamental integrals involving algebraic, trigonometric, exponential and logarithmic functions. Integration by substitution, by parts and by partial fractions. Integration using trigonometric identities. Integral as limit of a sum. Fundamental Theorem of Calculus. Properties of definite integrals.

II. Physics & Chemistry

Force and Inertia, Newton's First Law of motion; Momentum, Newton's Second Law of motion; Impulse; Newton's Third Law of motion. Law of conservation of linear momentum and its applications, Equilibrium of concurrent forces. Static and Kinetic friction, laws of friction, rolling friction. Dynamics of uniform circular motion: Centripetal force and its applications.

Work done by a constant force and a variable force; kinetic and potential energies, work energy theorem, power. Potential energy of a spring, conservation of mechanical energy, conservative and nonconservative forces; Elastic and inelastic collisions in one and two dimensions

Elastic behaviour, Stress-strain relationship, Hooke's Law, Young's modulus, bulk modulus, modulus of rigidity. Pressure due to a fluid column; Pascal's law and its applications. Viscosity, Stokes' law, terminal velocity, streamline and turbulent flow, Reynolds number. Bernoulli's principle and its applications. Surface energy and surface tension, angle of contact, application of surface tension - drops, bubbles and capillary rise. Heat, temperature, thermal expansion; specific heat capacity, calorimetry; change of state, latent heat. Heat transfer conduction, convection and Thermal equilibrium, zeroth law of thermodynamics, concept of temperature. Heat, work and internal energy. First law of thermodynamics. Second law of thermodynamics: reversible and irreversible processes. Carnot engine and its efficiency Electromagnetic induction; Faraday's law, induced emf and current; Lenz's Law, Eddy currents. Self and mutual inductance.

Alternating currents, peak and rms value of alternating current/ voltage; reactance and impedance; LCR series circuit, resonance; Quality factor, power in AC circuits, wattless current. AC generator and transformer Electromagnetic waves and their characteristics

Matter and its nature, Dalton's atomic theory; Concept of atom, molecule, element and compound; Physical quantities and their measurements in Chemistry, precision and accuracy, significant figures, S.I. Units, dimensional analysis; Laws of chemical combination; Atomic and molecular masses, mole concept, molar mass, percentage composition, empirical and molecular formulae; Chemical equations and stoichiometry. Classification of matter into solid, liquid and Measurable properties of gases; Gas laws - Boyle's law, Charles's law, Graham's law of diffusion, Avogadro's law, Dalton's law of partial pressure; Concept of Absolute scale of temperature; Ideal gas equation; Kinetic theory of gases (only postulates); Concept of average, root mean square and most probable velocities; Real gases, deviation from Ideal behaviour, compressibility factor and van der Waals equation.

Absorption- Physisorption and chemisorption and their characteristics, factors affecting absorption of gases on solids - Freundlich and Langmuir absorption isotherms, absorption from solutions. Colloidal state - distinction among true solutions, colloids and suspensions, classification of colloids - lyophilic, lyophobic; multi molecular, macromolecular and associated colloids (micelles), preparation and properties of colloids - Tyndall effect, Brownian movement, electrophoresis, dialysis, coagulation and flocculation; Emulsions and their characteristics.

III. Logical & Numeric Reasoning, standard model as in GRE etc.

IV. Engineering:

Covering Undergraduate syllabus in the Branch of Engineering in which the candidate holds degree.

Pattern of the Question Paper:

1. Mathematics – 20 questions
2. Physics & Chemistry – 20 questions
3. Logical and Numerical Reasoning – 30 questions
4. Engineering UG Specializations of Applicant - 30 questions (There shall be 30 questions each on Civil, Mechanical, Electrical or other specializations which the candidate can choose from).

Test Code: 19091 LL.M. (Maritime Law)

Test comprises of 100 questions.

Syllabus and Pattern of the Question Paper

Sl. No.	Syllabus Area	No. of Questions	Marks
1.	Jurisprudence Constitutional Law International Law Law of Torts Law of Contract Law of Crimes Companies Law	10 questions each 7x10 = 70 questions	280
2.	General Knowledge and Current affairs in the areas of Law	15	60
3.	Aptitude for Maritime Law course	15	60
	Total :	100	400