Syllabus

OF

WRITTEN ENTRANCE TEST
(WRET)

FOR

ADMISSION TO PH.D. (Sc.) PROGRAMME

Jadavpur University

Kolkata -700 032

INDEX

NOVEMBER 2017

DEPARTMENT OF PHYSICS
JADAVPUR UNIVERSITY

SYLLABUS OF WRITTEN ENTRANCE TEST (WRET)
FOR ADMISSION TO PH.D. (SC.) PROGRAMME

Part-I - Research Methodology (50%)
Part-II – Subject Specific (Physics) (50%)

Part-I - ***Research Methodology***

Definition of research problem, Selecting a problem, Choosing appropriate tools for handling the problem.

Basic knowledge for handling physical problems: Fundamental concepts and basic laws of Physics.

Errors in experimental measurements, propagation of errors (in simple cases), significant figures, dimensional analysis.

Elementary statistical concepts. For example, mean, median, standard deviation, distribution functions. Graphical representation of data.

Curve fitting, least square linear fit, error estimation of fitted parameters, limitation of least square method.

Basic computer knowledge, number system, fundamental of C language.

Part -II - Subject specific (As per Physics syllabus of NET examination)

DEPARTMENT OF CHEMISTRY
JADAVPUR UNIVERSITY

SYLLABUS OF WRITTEN ENTRANCE TEST (WRET)
FOR ADMISSION TO PH.D. (SC.) PROGRAMME

Part I. Research Methodology (50%)
Part II. Subject Specific (CHEMICAL SCIENCES) (50%)

Part I : <u>Research Methodology</u>

1. **Spectroscopy** Interaction of electromagnetic radiation with atoms and molecules and various types of spectra, Born-Oppenheimer approximation, condition of resonance and energy of absorption for various types of spectra, origin of atomic spectra.

   Theory, instrumentation, mechanism and applications of
   (a) rotational spectroscopy, (b) vibrational spectroscopy, FTIR, NDIR techniques, (c) Raman spectroscopy, (d) NMR spectroscopy, (e) ESR spectroscopy, (f) NQR, (g) Mössbauer, (h) Advanced mass spectrometric techniques, (i) Flame Photometric Experiments (Na, K analyses).
   Characterization and structure elucidation of compounds by IR, UV-Vis, Raman, ^{1}H & ^{13}C NMR, EPR, NQR, Mössbauer and Mass spectroscopic techniques.

2. **Electroanalytical Methods** Theory, instrumentation, mechanism and applications of
   (a) Polarography, (b) Stripping voltammetry, (c) Amperometry, (d) Cyclic voltammetry, (e) coulometry. Basic principles of electrosynthesis, electrocatalysis, electropolymerisation, Spectroelectrochemistry, Chronoamperometry, chronopotentiometry, Applications in energy studies and sensor development.

3. **Chemical methods of analysis**
   (a) Qualitative methods: identification of elements, radicals, functional groups, compounds (b) Quantitatve methods, examples: acid-base, redox, gravimetric, iodometric titrations, Quantitative determination of organic compounds, e.g. glucose, aniline.

4. **Environmental analysis**
   (a) COD, BOD, (b) Determination of heavy and toxic metals and compounds, (c) Drug Analysis: Vitamin C, Isoniazide etc.

5. **Chromatographic techniques**
   (a) Introduction and classification of chromatographic techniques, Principle, instrumentation and applications of different techniques: paper, TLC, Column, Ion-exchange, gas and liquid chromatography. HPLC: principle, applications, qualitative and quantitative analysis.

6. **Thermal Methods of Analysis**
   Introduction to thermal analysis: Thermogravimetric analysis (TGA), Differential thermogravimetric analysis (DTG), Differential thermal analysis (DTA) – Principles and methods, presentation of thermal data. Implication of combinational TG-DTA technique. Differential Scanning Calorimetry (DSC): a brief outline and a comparative discussion of DSC with DTA. Instrumentation TG, DTA

and DSC- Basic principles, brief outline (schematic diagram and methodology) of the instrument Factors affecting the results of thermal analysis.

7. X-ray Crystallography

Crystalline solid – single crystal and polycrystal (twining problem); lattice; unit cell – primitive and non-primitive unit cells. Unit cell parameters and crystal systems. Crystal symmetry – (i) point group elements and (ii) space group elements; crystal classes, HM notations, distribution in different systems and stereographic projections. Space group – HM notation, space groups in triclinic and monoclinic systems. Indexing of lattice planes; Miller indices.

X-ray, Cu K and Mo K radiation; X-ray diffraction; Bragg equation; Reciprocal lattice and its relation to direct lattice; Bragg reflection in terms of reciprocal lattice – sphere of reflection and limiting sphere; relation between d_{hkl} and lattice parameters. Methods of growing single crystals; crystal mounting; data collection; structure solution; structure refinement; R value

8. Electron Microscopy

Basic principles of different types of electron microscopy e.g. SEM, TEM, AFM etc. and their applications in nano-science and nano-technology. Qualitative and quantitative electron microscopy, EDS-SEM technique.

9. Radiochemical Methods of Analysis

Radio-chemical technique: working principles in radiochemical laboratory. Roles of carrier, isotopic exchange reaction and applications. Principles, applications and problems of neutron activation. Radio-active reagents in the analyses of trace elements. Radio Analytical Chemistry.

10. Analysis of data and units

Significant figures, mean and standard deviation; absolute and relative errors; least square analysis, linear regression; covariance and correlation coefficient. Analyses of units and dimensions.

11. Applications of computers in Chemistry

History of development of computers, general awareness of computer, CPU, imput and output devices, memory, storage devices, system softwares and application softwares, programming languages, interpreter and complier, algorithms, operating systems: Windows, Linux. Applications and uses of common softwares in chemistry. Basics of internet in chemistry education.

Part II. <u>Subject Specific (CHEMICAL SCIENCES)</u>

UNIT – I

1. Chemical periodicity
2. Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory), VBT, MOT.
3. Concepts of acids and bases, Hard-Soft acid base concept, Non-aqueous solvents.
4. Main group elements and their compounds: Allotropy, synthesis, structure and bonding, industrial importance of the compounds.
5. Transition elements and coordination compounds: structure, bonding theories, spectral and magnetic properties, reaction mechanisms.
6. Inner transition elements: spectral and magnetic properties, redox chemistry, analytical applications.
7. Organometallic compounds: synthesis, bonding and structure, and reactivity. Organometallics in homogeneous catalysis.
8. Cages and metal clusters.

9. Bioinorganic chemistry: photosystems, porphyrins, metalloenzymes, oxygen transport, electron-transfer reactions; nitrogen fixation, metal complexes in medicine.
10. Nuclear chemistry: nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.

UNIT - II

1. Basic principles of quantum mechanics: Postulates; operator algebra; exactly solvable systems: particle-in-a-box, harmonic oscillator and the hydrogen atom, including shapes of atomic orbitals; orbital and spin angular momenta; tunneling.
2. Approximate methods of quantum mechanics: Variational principle; perturbation theory up to second order in energy; applications.
3. Atomic structure and spectroscopy; term symbols; many-electron systems and antisymmetry principle.
4. Chemical bonding in diatomics; elementary concepts of MO and VB theories; Huckel theory for conjugated π-electron systems.
5. Chemical applications of group theory; symmetry elements; point groups; character tables; selection rules.
6. Chemical thermodynamics: Laws, state and path functions and their applications; thermodynamic description of various types of processes; Maxwell's relations; spontaneity and equilibria; temperature and pressure dependence of thermodynamic quantities; Le Chatelier principle; elementary description of phase transitions; phase equilibria and phase rule; thermodynamics of ideal and non-ideal gases, and solutions.
7. Statistical thermodynamics: Boltzmann distribution; kinetic theory of gases; partition functions and their relation to thermodynamic quantities – calculations for model systems. BE and FD statistics.
8. Electrochemistry: Nernst equation, redox systems, electrochemical cells; Debye-Huckel theory; electrolytic conductance – Kohlrausch's law and its applications; ionic equilibria; conductometric and potentiometric titrations. Primary and secondary solvation, salting in and salting out effect, Debye Huckel theory, Laws of diffusion, Debye-Huckel-Onsager equation, transport properties. Fuel cell, photoelectrochemistry and solar cells.
9. Chemical kinetics: Empirical rate laws and temperature dependence; complex reactions; steady state approximation; determination of reaction mechanisms; collision and transition state theories of rate constants; unimolecular reactions; enzyme kinetics; salt effects; homogeneous catalysis; photochemical reactions; electron transfer reactions (outer and inner sphere), redox reactions.
10. Colloids and surfaces: Stability and properties of colloids; isotherms and surface area; heterogeneous catalysis.
11. Solid state: Crystal structures; Bragg's law and applications; band structure of solids.
12. Polymer chemistry: Molar masses; kinetics of polymerization.

UNIT - III

1. IUPAC nomenclature of organic molecules including regio- and stereoisomers.
2. Principles of stereochemistry: Configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity , asymmetric induction and synthesis.
3. Aromaticity: Benzenoid and non-benzenoid compounds – generation and reactions.

4. Organic reactive intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes.
5. Organic reaction mechanisms involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Determination of reaction pathways.
6. Common named reactions and rearrangements – applications in organic synthesis.
7. Organic transformations and reagents: Functional group interconversion including oxidations and reductions; common catalysts and reagents (organic, inorganic, organometallic and enzymatic). Chemo, regio and stereoselective transformations.
8. Concepts in organic synthesis: Retrosynthesis, disconnection, synthons, linear and convergent synthesis, umpolung of reactivity and protecting groups.
9. Pericyclic reactions – electrocyclisation, cycloaddition, sigmatropic rearrangements and other related concerted reactions. Principles and applications of photochemical reactions in organic chemistry.
10. Synthesis and reactivity of common heterocyclic compounds containing one and two heteroatoms (O, N, S).
11. Chemistry of natural products: Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids. Biogenesis of terpenoids and alkaloids.

UNIT - IV

1. Chemistry in nanoscience and technology.
2. Catalysis and green chemistry.
3. Medicinal chemistry.
4. Supramolecular chemistry.
5. Environmental chemistry.

DEPARTMENT OF MATHEMATICS
JADAVPUR UNIVERSITY

SYLLABUS OF WRITTEN ENTRANCE TEST (WRET)
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Part I. Research Methodology (50%)
Part II. Subject Specific (MATHEMATICS) (50%)

Part I : Research Methodology
(MATHEMATICAL METHODS):

Numerical methods: Solution of Algebraic Equations, Solution of System of Linear Equations, Numerical Integration, Solution of ODE.

Probability: Definition of Probability, Random variables, Probability Distribution Functions, Mean, Median, Mode, Skewness and Kurtosis, Binomial, Poisson, Geometric, Normal and Uniform distributions, Moment Generating Function, Characteristic Function.

Statistical Methods: Population, Sampling, Collection of data, Classification of data, Measures of Central Tendency, Measures of Dispersion, Correlation and Regression, Estimation of Parameters, Interval Estimation, Confidence Interval, Testing of Hypothesis, Null Hypothesis, Alternative Hypothesis, Types of Errors, Best Critical Region, Power of a Test.

Integral Transform: Laplace Transform, Fourier Transform.

Part II : Subject Specific (Mathematics)
Syllabus for Mathematics will be as per UGC – NET syllabus.

DEPARTMENT OF GEOLOGICAL SCS.

JADAVPUR UNIVERSITY

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Part II. Subject Specific (50%)

Part-I (Research Methodology)

1. **Field techniques in Geology**:

   Interpretation of geological maps, Interpretation of Field outcrops, Reconstruction of sedimentological and metamorphic facies map, study of fossils and their applications for reconstruction of geological history, Application of advance methods (Remote sensing data synthesis, GPS and seismic data), techniques of geological sampling, Field selection for engineering construction.

2. **Methods of optical microscopy in geological study**
   Basic theory and its application of optical mineralogy for studying thin section of minerals and rocks, Textural interpretation for petrological phenomena.

3. **Laboratory techniques for geological sample preparation**:

   Thin section, Heavy and Magnetic mineral separation, Powder sample preparation.

4. **Advance analytical methods in Earth Sciences**

   Electron Probe Micro Analyser (EPMA), Scanning Election Microscopy (SEM), X-Ray Diffraction (XRD), MASS SPECTROMETER, X-Ray Fluorescence (XRF), Raman Spectroscopy, Fluid inclusion study, Cathodoluminescence study, Geochrononological Methods.

   Radiogenic isotopes, TL, OSL, Fission track.

5. **Application of stable isotopes in interpretation of geological processes:**

   Carbon, Oxygen, Strontium and sulphur isotopes

6. **Application of Geophysical methods in Earth Sciences**

   Seismic, gravity, electrical, Magnetic methods

Part-II (Subject Specific)

[Following CSIR-UGC NET Syllabus]

1. **The Earth and the Solar System:**
   Milky Way and the solar system. Modern theories on the origin of the Earth and other planetary bodies. Earth‟s orbital parameters, Kepler‟s laws of planetary motion, Geological Time Scale; Space and time scales of processes in the solid Earth, atmosphere and oceans. Radioactive isotopes and their applications. Meteorites Chemical composition and the Primary differentiation of the earth. Basic principles of stratigraphy. Theories about the origin of life and the nature of fossil record. Earth‟s gravity and magnetic fields and its thermal structure: Concept of Geoid and, spheroid; Isostasy.

2. **Earth Materials, Surface Features and Processes:**
   Gross composition and physical properties of important minerals and rocks; properties and processes responsible for mineral concentrations; nature and distribution of rocks and minerals in different units of the earth and different parts of India. Physiography of the Earth; weathering, erosion, transportation and deposition of Earths material; formation of soil, sediments and sedimentary rocks; energy balance of the Earth‟s surface processes; physiographic features and river basins in India

3. **Interior of the Earth, Deformation and Tectonics:**
   Basic concepts of seismology and internal structure of the Earth. Physico-chemical and seismic properties of Earth‟s interior. Concepts of stress and strain. Behaviour of rocks under stress; Folds, joints and faults. Earthquakes – their causes and measurement. Interplate and intraplate seismicity. Paleomagnetism, sea floor spreading and plate tectonics.

4. **Environmental Earth Sciences:**
   Properties of water; hydrological cycle; water resources and management. Energy resources, uses, degradation, alternatives and management; Ecology and biodiversity. Impact of use of energy and land on the environment. Exploitation and conservation of mineral and other natural resources. Natural hazards. Elements of Remote Sensing.

5. **Mineralogy and Petrology:**
   Concept of point group, space group, reciprocal lattice, diffraction and imaging. Concepts of crystal field theory and mineralogical spectroscopy. Lattice defects (point, line and planar). Electrical, magnetic and optical properties of minerals. Bonding and crystal structures of common oxides, sulphides, and silicates. Transformation of minerals – polymorphism, polytypism, and polysomatism. Solid solution and exsolution. Steady-state geotherms. Genesis, properties, emplacement and crystallization of magmas. Phase equilibrium studies of simple systems, effect of volatiles on melt equilibria. Magma-mixing, -mingling and -immiscibility.
   Metamorphic structures and textures; isograds and facies. Mineral reactions with condensed phases, solid solutions, mixed volatile equilibria and thermobarometry. Metamorphism of pelites, mafic-ultra mafic rocks and siliceous dolomites. Material transport during metamorphism. P-T-t path in regional metamorphic terrains, plate tectonics and metamorphism. Petrogenetic aspects of important rock suites of India, such as the Deccan Traps, layered intrusive complexes, anorthosites, carbonatites, charnockites, alkaline rocks, Kimberlites, ophiolites and granitoids.

6. **Structural geology and geotectonics:**
   Theory of stress and strain. Behaviour of rocks under stress. Mohr circle. Various states of stress and their representation by Mohr circles. Different types of failure and sliding criteria. Geometry and mechanics of fracturing and conditions for reactivation of pre-existing discontinuities. Common types of finite strain ellipsoids. L-, L-S-, and S-tectonic fabrics. Techniques of strain analysis. Particle paths and flow patterns. Progressive strain history. Introduction to deformation mechanisms. Role of fluids

in deformation processes. Geometry and analyses of brittle-ductile and ductile shear zones. Sheath folds. Geometry and mechanics of development of folds, boudins, foliations and lineations. Interference patterns of superposed fold. Fault-related folding. Gravity induced structures. Tectonic features of extensional-, compressional-, and strike-slip-terrains and relevance to plate boundaries. mantle plumes. Himalayan Orogeny; concept of super continent, their assembly and breakup.

7. Paleontology and its applications:

Theories on origin of life. Organic evolution – Punctuated Equilibrium and Phyletic Gradualism models. Mass extinctions and their causes. Application of fossils in age determination and correlation. Paleoecology, Life habitats and various ecosystems, Paleobiogeography. Modes of preservation of fossils and taphonomic considerations. Types of microfossils. Environmental significance of fossils and trace fossils. Use of microfossils in interpretation of sea floor tectonism. Application of micropaleontology in hydrocarbon exploration. Oxygen and Carbon isotope studies of microfossils and their use in paleoceanographic and paleoclimatic interpretation. Important invertebrate fossils, vertebrate fossils, plant fossils and microfossils in Indian stratigraphy.

8. Sedimentology and stratigraphy:

Classification of sediments and sedimentary rocks ; elastic, volcanoclastic and chemical. Classification of elastic rocks. Flow regimes and processes of sediment transport. Sedimentary textures and structures. Sedimentary facies and environments, reconstruction of paleoenvironments. Formation and evolution of sedimentary basins. Diagenesis of siliciclastic and carbonate rocks.

Recent developments in stratigraphic classification. Code of stratigraphic nomenclature – Stratotypes, Global Boundary Stratotype Sections and Points (GSSP). Lithostratigraphic, chronostratigraphic and biostratigraphic subdivisions. Methods of startigraphic correlation including Shaw‟s Graphic correlation. Concept of sequence stratigraphy. Rates of sediment accumulation, unconformities. Facies concept in Stratigraphy – Walther‟s law. Methods for paleogeographic reconstruction. Earth‟s Climatic History. Phanerozoic stratigraphy of India with reference to the type areas– their correlation with equivalent formations in other regions. Boundary problems in Indian Phanerozoic stratigraphy.

9. Geochemistry: Atomic Structure and properties of elements, the Periodic Table; ionic substitution in minerals; Phase rule and its applications in petrology, thermodynamics of reactions involving pure phases, ideal and non-ideal solutions, and fluids; equilibrium and distribution coefficients. Nucleation and diffusion processes in igneous, metamorphic and sedimentary environments, redox reactions and Eh-pH diagrams and their applications.

Mineral/mineral assemblages as „sensors‟ of ambient environments. Geochemical studies of aerosols, surface-, marine-, and ground waters. Radioactive decay schemes and their application to geochronology and petrogenesis. Stable isotopes and their application to earth system processes; geochemical differentiation of the earth; geochemical cycles.

10. Economic geology:

Magmatic, hydrothermal and surface processes of ore formation. Metallogeny and its relation to crustal evolution; Active ore-forming systems, methods of mineral deposit studies including ore microscopy, fluid inclusions and isotopic systematics; ores and metamorphism- cause and effect relationships. Geological setting, characteristics, and genesis of ferrous, base and noble metals. Origin, migration and entrapment of petroleum; properties of source and reservoir rocks; structural, stratigraphic and combination traps. Methods of petroleum exploration. Concepts of petrophysics, Petroliferous basins of India. Origin of peat, lignite, bitumen and anthracite. Classification, rank and grading of coal; coal petrography, coal resources of India. Gas hydrates and coal bed methane. Nuclear and non-conventional energy resources.

11. Precambrian geology and crustal evolution:

Evolution of lithosphere, hydrosphere, atmosphere, biosphere, and cryosphere;, lithological, geochemical and stratigraphic characteristics of granite – greenstone and granulite belts. Stratigraphy and geochronology of the cratonic nuclei, mobile belts and Proterozoic sedimentary basins of India. Life in Precambrian. Precambrian – Cambrian boundary with special reference to India.

12. Quaternary geology: Definition of Quaternary. Quaternary Stratigraphy – Oxygen Isotope stratigraphy, biostratigraphy and magnetostratigraphy. Quaternary climates – glacial-interglacial cycles, eustatic changes, proxy indicators of paleoenvironmental/ paleoclimatic changes, - land, ocean and cryosphere (ice core studies). Responses of geomorphic systems to climate, sea level and tectonics on variable time scales in the Quaternary, Quaternary dating methods, –radiocarbon, Uranium series, Luminescence, Amino-acid. Quaternary stratigraphy of India– continental records (fluvial, glacial, aeolian, palaeosols and duricrust); marine records; continental-marine correlation of Quaternary record.

Evolution of man and Stone Age cultures. Plant and animal life in relation to glacial and interglacial cycles during Quaternary.Tectonic geomorphology, neotectonics, active tectonics and their applications to natural hazard assessment.

13. Remote Sensing and GIS:

Elements of photogrammetry, elements of photo-interpretation, electromagnetic spectrum, emission range, film and imagery, sensors, geological interpretations of air photos and imageries. Global positioning systems. GIS- data structure, attribute data, thematic layers and query analysis.

14. Engineering Geology:

Engineering properties of rocks and physical characteristics of building stones, concretes and other aggregates. Geological investigations for construction of dams, bridges, and tunnels. Remedial measures. Mass movements with special emphasis on landslides and causes of hillslope instability. Seismic design of buildings.

15. Mineral Exploration:

Geological, geophysical, geochemical and geobotanical methods of surface and sub-surface exploration on different scales. Sampling, assaying and evaluation of mineral deposits.

16. Hydrogeology:

Groundwater, Darcy‟s law, hydrological characteristics of aquifers, hydrological cycle. Precipitation, evapotranspiration and infiltration processes. Hydrological classification of water-bearing formations. Fresh and salt-water relationships in coastal and inland areas. Groundwater exploration and water pollution. Groundwater regimes in India.

17. Geomorphology:

Concepts in geomorphology. Historical and process Geomorphology. Landforms in relation to climate, rock type, structure and tectonics. Processes – weathering, pedogenesis, mass movement, erosion, transportation and deposition. Geomorphic processes and landforms – fluvial, glacial, eolian, coastal and karst. River forms and processes – stream flow, stage-discharge relationship; hydrographs and flood frequency analysis. Submarine relief. Geomorphology and topographic analysis including DEM, Environmental change– causes, effects on processes and landforms. Extra-terrestrial geomorphology.

18. Environmental Geography:

Man-land relationship. Resources – renewable and non-renewable. Natural and man-made hazards – droughts, floods, cyclones, earthquakes, landslides, tsunamis. Ecological balance, environmental pollution and deterioration.

19. Geography of India:

Physiography, drainage, climate, soils and natural resources – the Himalaya, Ganga-Brahmaputra Plains, and peninsular India Precambrian shield, the Gondwana rift basins, Deccan Plateau.

20. Gravity and Magnetic fields of the earth:

Normal gravity field; Clairaut‟s theorem; Shape of the earth; deflection of the vertical, geoid, free-air, Bouguer and isostatic anomalies, isostatic models for local and regional compensation. Geomagnetic field, secular and transient variations and their theories; palaeomagnetism, construction of polar wandering curves.

21. Plate Tectonics and Geodynamics:

Marine magnetic anomalies, sea floor spreading; mid-oceanic ridges and geodynamics; plate tectonics hypothesis; plate boundaries and seismicity. Heat flow mechanisms, thermal moddling of earth,core-mantle convection and mantle plumes.

22. Seismology and Elastic theory:

Seismometry: short period, long period, broad band and strong motion; elements of earthquake seismology; seismic sources: faulting source, double couple hypothesis, seismic moment tensor, focal mechanism and fault plane solutions; seismic gaps; seismotectonics and structure of the earth; Himalayan and stable continental region earthquakes, reservoir induced seismicity; seismic hazards; earthquake prediction, travel time residuals, velocity anomalies, seismic tomography.

23. Gravity and Magnetic Methods:

Gravimeters and magnetometers; data acquisition from land, air and ship; corrections and reduction of anomalies; ambiguity; regional and residual separation; continuation and derivative calculations; interpretation of anomalies of simple geometric bodies, single pole, sphere, horizontal cylinder, sheet, dyke and fault. Forward modelling and inversion of arbitrary shaped bodies and 2-D, 3-D interfaces. Interpretations in frequency domain.

24. Electrical and Electromagnetic Methods:

Electrical profiling and sounding, typical sounding curves, pseudo-sections; resistivity transform and direct interpretation; induced polarization methods. Electromagnetic field techniques; elliptic polarization, in-phase and out of phase components, horizontal and vertical loop methods; interpretation; VLF (very low frequency); AFMAG (Audio frequency magnetic) methods; and central frequency sounding; transient electromagnetic methods; magneto-telluric method; geomagnetic depth sounding.

25. Well logging:

Open hole, cased hole and production logging; Electrical logs; lateral, latero, induction, temperature, S.P; porosity logs; sonic, density, neutron; natural gamma; determination of formation factor, porosity, permeability, density, water saturation, lithology; logging while drilling.

DEPARTMENT OF LIFE SC. & BIOTECHNOLOGY

JADAVPUR UNIVERSITY

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Part I. Research Methodology

Unit I
Basics Concepts
Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions-Electromobility shift assay; DNaseI footprinting; Methyl interference assay

Unit II
Cloning Vectors
Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; EMBL; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pETbased
vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based
vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors

Unit III
Cloning Methodologies
Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Far-western cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression

Unit IV
PCR and Its Applications
Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse
transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; Tvectors;

Proof reading enzymes; PCR in gene recombination; Deletion; addition; Overlap extension; and SOEing; Site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test)

Unit V

Medical Biotechnology

Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing; Chemical Synthesis of oligonucleotides; Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; Introduction to siRNA; siRNA technology; Micro RNA; Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knockout mice; Disease model; Somatic and germ-line therapy- in vivo and ex-vivo; Suicide gene therapy; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array.

Unit VI

Antigen antibody interaction by immunodiffusion, immunoelectrophoresis, Elisa assay, Indirect immunolabeling, immunoprecipitation, Western blotting, Cytochemical assays: Histology, tissue fixation, paraffin embedding, immune staining, Cytotoxicity assat by MTT, Trypan blue exclusion test, Chromosome analysis and micronucleus assay, Hybridization techniques: Southern,Northern blot,Nucleotide amplification: different types of PCR and real time PCR, Gene regulation and genome editting: siRNA and miRNA, cloning, Transgenic and knockout techniques

Unit VII

Tools used in Bioinformatics

Databsae; Various type of databases, NCBI database search; File format: GenBank, FASTA, FASTQ; Sequence alignment: alignment algorithm (Smith-Waterman & Needleman-Wunsch) alignment techniques (BLAST, CLUSTALW); Phylogenetic analysis; Structure analysis: study of primary, secondary and tertiary structure of protein and visualise them (rasmol, pymol, cn3d), Homology modelling.

Part II. Subject Specific

As per NET Syllabus