ANNEXURE-II
SYLLABUS FOR THE POST OF CHEMIST/TSGENCO

Section –A Total 80 Marks

INORGANIC CHEMISTRY

Chemical periodicity: Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory).

Acids and Bases: Concepts of acids and bases, Hard-Soft acid base concept, non-aqueous solvents.

Main group elements and their compounds: Allotropy, synthesis, structure and bonding, industrial importance of the compounds.

Transition elements and co-ordination compounds: Structure, bonding theories, spectral and magnetic properties, reaction mechanisms.

Inner transition elements: Spectral and magnetic properties, redox chemistry, analytical applications.

Organometallic Compounds: Synthesis, bonding and structure, reactivity. Organometallics in homogeneous catalysis - Cages and metal clusters.

Nuclear chemistry: Nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.

Inorganic Spectroscopy: Characterisation of inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV-Vis, NQR, MS, Electron spectroscopy and microscopic techniques.

ANALYTICAL CHEMISTRY

Introduction to Analytical Chemistry: Safety in laboratory; Analytical balances – types, care & use, weights and reference mass; Water for lab use – different grades and methods of purification of water; Reagents and Standard solutions – Expression and units of concentrations, Classification of Errors- Systematic & random errors, identification and reduction of these errors; Significant figures; Qualitative and Quantitative analysis; Statistical functions and reliability of results; Comparison of results – Student's t-test, F-test & paired-t test.

Gravimetry: Principles of precipitation gravimetry; Nucleation, precipitation and growth of precipitates; Particle size and filterability of precipitates; Precipitation from homogeneous solution; Co precipitation - impurities in precipitation, Washing, drying, incineration of precipitates; Use of organic reagents in Gravimetric analysis.

Titrimetric Analysis: Principles underlying titrimetric methods: Primary standards & standard solutions; Equivalence point and endpoint; detection of end point; types of titrations.

Redox titrations: Principle and detection of equivalance point by visual & potentiometric methods. Applications - Use of Jones reductor; Karl Fischer reagent for water determination.

Complexometric titrations: Principles of Complexometric titrations, stability constants, Use of EDTA for the determination of metals and practical considerations.

Thermal Analysis: Thermal techniques-Introduction, types of thermo analytical methods. Thermogravimetry principle and applications of thermogravimetry, differential thermal analysis- principle and applications of DTA. Differential scanning calorimetry. DSC: Principle, and application of DSC.

Techniques of Chromatography:
i. Introduction, Classification of chromatographic techniques, differential migration rates, partition ratio, retention time, relation between partition ratio and retention time, capacity factor, selectivity factor. Efficiency of separation - resolution, diffusion, plate theory and rate theory.
ii. GC: Principle, instrumentation, detectors - TCD, FID, ECD. Derivatisation techniques, PTGC.
iii. HPLC: Principle, instrumentation, detectors - UV detectors, Photodiode array detector, fluorescence detector.
iv. Applications: Methods of quantitation for GC and HPLC: GC analysis of hydrocarbons in a mixture.
v. Ion-exchange chromatography: Ion-exchange resins, structure of resins. Ion exchange equilibria, selectivity, ion exchange chromatography with reference to anions and cations, applications separation of rare earth metal ions, Amino acid analysis, purification of water for laboratory and industrial use, deionized water.

PHYSICAL CHEMISTRY

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. Approximate methods of quantum mechanics: Variational principle; perturbation theory up to second order in energy; applications.

Atomic structure and spectroscopy: Term symbols; many-electron systems and antisymmetry principle. Chemical bonding in diatomics; elementary concepts of MO and VB theories; Huckel theory for conjugated π-electron systems.
Molecular spectroscopy: Rotational and vibrational spectra of diatomic molecules; electronic spectra; IR and Raman activities – selection rules; basic principles of magnetic resonance.

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.

Statistical thermodynamics: Boltzmann distribution; kinetic theory of gases; partition functions and their relation to thermodynamic quantities – calculations for model systems.

Electrochemistry: Nernst equation, redox systems, electrochemical cells; Debye-Huckel theory; electrolytic conductance – Kohlrausch's law and its applications; ionic equilibria; conductometric and potentiometric titrations.

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.

Colloids and surfaces: Stability and properties of colloids; isotherms and surface area; heterogeneous catalysis.

Solid state: Crystal structures; Bragg's law and applications; band structure of solids.

Polymer chemistry: Molar masses; kinetics of polymerization.

ORGANIC CHEMISTRY

Introduction to Organic Chemistry: IUPAC nomenclature of organic molecules including regio- and stereoisomers.

Principles of Stereochemistry: Configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction.

Aromaticity: Benzenoid and non-benzenoid compounds – generation and reactions.

Organic reactive intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes.

Organic reaction mechanisms: Involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Determination of reaction pathways. Common named reactions and rearrangements – applications in organic synthesis. 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.

Concepts in organic synthesis: Retrosynthesis, disconnection, synthons, linear and convergent synthesis, umpolung of reactivity and protecting groups. Asymmetric synthesis: Chiral auxiliaries, methods of asymmetric induction – substrate, reagent and catalyst-controlled reactions; determination of enantiomeric and diastereomeric excess; enantio-discrimination. Resolution – optical and kinetic.
Structure determination of organic compounds by IR, UV-Vis, ^{1}H & ^{13}C NMR and Mass spectroscopic techniques.

Pericyclic reactions: Electrocyclization, cycloaddition, sigmatropic rearrangements and other related concerted reactions. Principles and applications of photochemical reactions in organic chemistry.

Chemistry of natural products: Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids. Biogenesis of terpenoids and alkaloids.

ENVIRONMENTAL AND GENERAL CHEMISTRY

Environmental Chemistry: Composition of air. Particles, ions and radicals in the atmosphere. Chemical speciation. Chemical processes in the formation of inorganic and organic particulate matters, thermo chemical and photo chemical reactions in the atmosphere, Oxygen and Ozone chemistry. Photochemical smog.
Hydrological cycle. Water as a universal solvent. Concept of DO, BOD and COD. Sedimentation, coagulation, flocculation, filtration, pH and Redox potential (Eh).
Inorganic and organic components of soils. Biogeochemical cycles – nitrogen, carbon, phosphorus and sulphur.
Toxic chemicals: Pesticides and their classification and effects. Biochemical aspects of heavy metals (Hg, Cd, Pb, Cr) and metalloids (As, Se). CO, O_3, PAN, VOC and POP. Carcinogens in the air.

Air Pollution and Control: Sources and types of Pollutants - Natural and anthropogenic sources, primary and secondary pollutants. Criteria air pollutants. Sampling and monitoring of air pollutants (gaseous and particulates); period, frequency and duration of sampling. Principles and instruments for measurements of (i) ambient air pollutants concentration and (ii) stack emissions. Indian National Ambient Air Quality Standards. Impact of air pollutants on human health, plants and materials. Acid rain. Dispersion of air pollutants. Mixing height/depth, lapse rates, Gaussian plume model, line source model and area source model. Control devices for particulate matter: Principle and working of: settling chamber, centrifugal collectors, wet collectors, fabric filters and electrostatic precipitator. Control of gaseous pollutants through adsorption, absorption, condensation and combustion including catalytic combustion. Indoor air pollution, Vehicular emissions and Urban air quality.

Water Pollution and Control: Types and sources of water pollution. Impact on humans, plants and animals. Measurement of water quality parameters: sampling and analysis for pH, EC, turbidity, TDS, hardness, chlorides, salinity, DO, BOD, COD, nitrates, phosphates, sulphates, heavy metals and organic contaminants. Microbiological analysis – MPN. Indian standards for drinking water (IS:10500, 2012). Drinking water treatment: Coagulation and flocculation, Sedimentation and Filtration, Disinfection and Softening. Wastewater Treatment: Primary, Secondary and Advanced treatment methods. Common effluent treatment plant.

Noise Pollution and Control: Sources, weighting networks, measurement of noise indices (L_{eq}, L_{10}, L_{90}, L_{50}, L_{DN}, TNI). Noise dose and Noise Pollution standards. Noise control and abatement measures: Active and Passive methods. Vibrations and their measurements. Impact of noise and vibrations on human health.

Hazardous waste Management: Types, characteristics and health impacts. Hazardous waste management: Treatment Methods – neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal.
Fly ash: sources, composition and utilisation.
Plastic waste: sources, consequences and management.

Water Technology: Hardness of water – Temporary and permanent Hardness-units. Desalination of Brackish water - Reverse Osmosis and Electro dialysis. Industrial treatment of water - Lime soda ash method - Chemical reaction – problems - zeolite and ion exchange process. Boiler troubles - scale and sludge formation – Caustic Embrittlement and boiler corrosion - Internal conditioning methods - phosphate and carbonate conditioning - priming and Foaming.

Corrosion and its control: Magnitude of the problem, theories of corrosion, Chemical and electrochemical corrosion, corrosion reactions, factors affecting corrosion- nature of metal, purity of metal, electrochemical series, over voltage, nature of oxide film, nature of corrosion product, nature of environment, effect of temperature, effect of pH, effect of oxidant, humidity. Corrosion control methods design and material selection, cathodic protection, sacrificial anode, impressed current cathode.

Fuel Technology: Classification of fuels, characteristics of fuels - calorific value units (lower, higher) and its determination - Bomb calorimetric method. Solid fuels - classification of coal, Rank analysis of coal - proximate and ultimate analysis. Stoichiometric calculations of coal combustion.

Power Plant Engineering: Rankine and Brayton cycles with regeneration and reheat, Fuels and their properties, Flue gas analysis, Boilers, steam turbines and other Power Plant components like condensers, air ejectors, electrostatic precipitators and cooling towers – their theory and design, types and applications.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept and electrical analogy, heat transfer through fins; unsteady heat conduction, lumped parameter system, Heisler's charts; thermal boundary layer, dimensionless parameters in free and forced convective heat transfer, heat transfer correlations for flow over flat plates and through pipes, effect of turbulence; heat exchanger performance, LMTD and NTU methods; radiative heat transfer, Stefan- Boltzmann law, Wien's displacement law, black and grey surfaces, view factors, radiation network analysis.

Section –B Total 20 Marks.

General Awareness and Numerical Ability:

i) Analytical & Numerical Ability
ii) General Awareness
iii) English
iv) Telangana Culture, Movement. Post formation development of Telangana State.
v) Basic knowledge of Computer for handling office works such as MS Office etc.

Sd/-
CGM(Adm)