SCHEME OF PAPER & DURATION OF EXAMINATION

No. of Questions	Duration
30- General Aptitude **70- Domain**	**120 Minutes**

Note:

- General Aptitude Paper will be based on problems/questions on Logical Reasoning, Data Interpretation, Quantitative Aptitude, General Awareness, verbal ability, reasoning etc.
- Domain Paper: Refer syllabus mentioned below
- The syllabus/topics and sample questions mentioned are indicative in nature and candidates are expected to possess significant knowledge/proficiency pertaining to their qualifying degree/Post graduation.

SYLLABUS- FIXED TERM PROJECT ASSOCIATE

MSc/BSc- Chemistry

Inorganic Chemistry

Chemical periodicity, Structure and bonding in homo- and heteronuclear molecules, VSEPR Theory, Concepts of acids and bases, Main group elements and their compounds: synthesis, structure and bonding, Transition elements and coordination compounds, spectral and magnetic properties, Organometallic compounds: synthesis, bonding and structure, reactivity and catalysis, Analytical chemistry- separation, spectroscopic, electro- and thermoanalytical methods, Characterisation of inorganic compounds by IR, Raman, NMR, EPR, UV-vis, MS, electron spectroscopy and microscopic techniques, Nuclear chemistry: nuclear reactions, fission and fusion, radio-analytical techniques

Physical Chemistry:

Basic principles of quantum mechanics: Postulates; operator algebra; particle-in-a-box, harmonic oscillator, hydrogen atom, tunneling; Atomic structure and spectroscopy; MO and VB theories; Chemical applications of group theory; symmetry elements; point groups, Molecular spectroscopy: Rotational, vibrational spectra; electronic spectra; IR and Raman Spectra – selection rules; magnetic resonance, Chemical thermodynamics: Laws, state and path functions; Maxwell's relations; spontaneity and equilibria; Le Chatelier principle; phase equilibria and phase rule; thermodynamics of gases, and solutions. Statistical thermodynamics: Boltzmann distribution; kinetic theory of gases; Electrochemistry, Chemical kinetics: Empirical rate laws, temperature dependence; steady state approximation; determination of reaction mechanisms; collision and transition state theories, enzyme kinetics, Colloids and surfaces; isotherms and surface area; heterogeneous catalysis Solid state: Crystal structures; Bragg's law; Polymer chemistry, Data analysis: Mean and standard deviation; absolute and relative errors

Organic Chemistry

IUPAC nomenclature, stereochemistry: Configurational and conformational isomerism; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction. Aromaticity, Organic reactive intermediates: carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes: Organic reaction mechanisms: addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Common named reactions and rearrangements. Organic transformations: Functional group interconversion; common catalysts and reagents, Chemo, regio and stereoselective transformations. Asymmetric synthesis,substrate, reagent and catalyst controlled reactions; enantiomeric resolution – optical and kinetic; Pericyclic reactions; photochemical reactions, heterocyclic compounds; Chemistry of natural products: Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids, structure determination by IR, UV-Vis, 1H & 13C NMR and Mass spectroscopic techniques.

SAMPLE QUESTION:

Q. Bond order of which among the following molecules is zero?

A. F2
B. O2
C. Be2
D. Li2

Q. The mass of one Avogadro number of helium atom is

A. 1.00 gram
B. 4.00 gram
C. 8.00 gram
D. 4 x 6.02 x 1023 gram

MSc/BSc- Microbiology/Biotechnology

Microbial Growth: Effect of Physical (Temperature, pH, Osmotic Pressure) and Chemical (Carbon, Nitrogen, Phosphorous, Sulphur, Trace elements, oxygen) parameters on microbial growth. Types of Growth Culture media, Phases of Growth, Growth Measurement Techniques, Microbial Growth Control methods (Chemical and Physical)

Methods in microbial isolation: (Enrichment techniques, Selective growth media etc.), cultivation conditions, identification (based on colony morphology, microscopic observations etc.), microbial staining techniques. Bioreactor parts and operation, sterilization, calibration, anaerobic culturing and equipment,

Fermentation and Downstream processing: Modes of Fermentation, Fermentation Scale-up, Bacterial, fungal and algal fermentations, basics of centrifugation, filtration, concentration etc.

Advanced Biofuels: Basics about 1st, 2nd ,3rd and 4th generation biofuels

Analytical Techniques: Principles and applications of HPLC, GC, GPC, Chromatography

Protein and DNA: Basics of DNA isolation, estimation, quantification. Basic molecular biology, Cloning techniques, Protein Quantification, assays, kinetics

SAMPLE QUESTION:

Q, In Gas Chromatography, the stationary phase is

a) Solid
b) Liquid
c) Gas
d) Organic Solvents

Q. Which among the following are not used as raw materials for alcohol production?

a) corn
b) molasses
c) whey
d) grapes

Diploma- Chemical Engg./Petroleum refining

Process Calculations and Thermodynamics

Steady and unsteady state mass and energy balances including multiphase, multicomponent, reacting and non-reacting systems. Use of tie components; recycle, bypass and purge calculations; Gibb's phase rule and degree of freedom analysis. First and Second laws of thermodynamics. Applications of first law to close and open systems. Second law and Entropy. Thermodynamic properties of pure substances: Equation of State and residual properties, properties of mixtures: partial molar properties, fugacity, excess properties and activity coefficients; phase equilibria: predicting VLE of systems; chemical reaction equilibrium.

Fluid Mechanics and Mechanical Operations

Fluid statics, Newtonian and non-Newtonian fluids, shell-balances including differential form of Bernoulli equation and energy balance, Macroscopic friction factors, dimensional analysis and similitude, flow through pipeline systems, flow meters, pumps and compressors, elementary boundary layer theory, flow past immersed bodies including packed and fluidized beds, Turbulent flow: fluctuating velocity, universal velocity profile and pressure drop. Particle size and shape, particle size distribution, size reduction and classification of solid particles; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, agitation and mixing; conveying of solids.

Heat Transfer

Steady and unsteady heat conduction, convection and radiation. Thermal boundary layer and heat transfer coefficients Boiling, condensation and evaporation.Types of heat exchangers and evaporators and their process calculations, cooling towers, furnace calculations. Design of double pipe, shell and tube heat exchangers, and single and multiple effect evaporators.

Mass Transfer

Fick's laws, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; Stage-wise and continuous contacting and stage efficiencies; HTU & NTU concepts.Design and operation of equipment for distillation (flash, multi-component

distillation etc), absorption and stripping, leaching, liquid-liquid extraction, drying, membrane separation, humidification, dehumidification and adsorption.

Chemical Reaction Engineering

Theories of reaction rates.Kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors. Development of rate laws, Residence time distribution, single parameter model. Non-isothermal reactors. Catalysis and catalytic reactions, catalyst deactivation and regeneration, Kinetics of heterogeneous catalytic reactions

Diffusion effects in catalysis. Different type of industrial reactors - Fixed bed, fluidized bed, trickle bed, slurry bed

Instrumentation and Process Control

Measurement of process variables. Sensors, transducers and their dynamics. Process modeling and linearization. Transfer functions and dynamic responses of various systems, systems with inverse response, process reaction curve, controller modes (P, PI, and PID). Control valves; analysis of closed loop systems including stability, frequency response, controller tuning, cascade and feed forward control.

Chemical Technology

Inorganic chemical industries (sulfuric acid, phosphoric acid, chlor-alkali industry)

Fertilizers (Ammonia, Urea, SSP and TSP)

Natural products industries (Pulp and Paper, Sugar, Oil, and Fats)

Petroleum refining and petrochemicals

Polymerization industries (polyethylene, polypropylene, PVC and polyester synthetic fibers).

SAMPLE QUESTION

Q. The unit of Space time which is used as the performance measure of flow reactors

(A)Time

(B)(time)-1

(C)Velocity

(D)(velocity)-1

Q. Out of the following, which is a catalytic process

(A)Visbreaking

(B)Thermal cracking

(C)Hydrotreating

(D) Delayed coking

Diploma/PG Diploma Plastic Processing & Testing

1. Polymer Science & Technology
2. Plastics Materials and its Applications
3. Plastics Processing Technology
4. Plastics Testing (Equipments, Procedures)
5. Plastics Product & Mould Design
6. Plastics Recycling & Waste Management
7. Plastic processing Machine Maintenance & Trouble shooting

SAMPLE QUESTION

Q. What is the unit of MFI ?

a) gm/10 min

b) cm/g

c) N/m2

d) g/10 s

Q. Which process is most economical for making bottle caps?

a) Compression Molding

b) Cast Film

c) Injection Molding Process

d) Extrusion

SYLLABUS- FIXED TERM RESEARCH ASSOCIATE

M Tech Chemical Engineering

Process Calculations and Thermodynamics

Steady and unsteady state mass and energy balances including multiphase, multicomponent, reacting and non-reacting systems. Use of tie components; recycle, bypass and purge calculations; Gibb's phase rule and degree of freedom analysis. First and Second laws of thermodynamics. Applications of first law to close and open systems. Second law and Entropy. Thermodynamic properties of pure substances: Equation of State and residual properties, properties of mixtures: partial molar properties, fugacity, excess properties and activity coefficients; phase equilibria: predicting VLE of systems; chemical reaction equilibrium.

Fluid Mechanics and Mechanical Operations

Fluid statics, Newtonian and non-Newtonian fluids, shell-balances including differential form of Bernoulli equation and energy balance, Macroscopic friction factors, dimensional analysis and similitude, flow through pipeline systems, flow meters, pumps and compressors, elementary boundary layer theory, flow past immersed bodies including packed and fluidized beds, Turbulent flow: fluctuating velocity, universal velocity profile and pressure drop. Particle size and shape, particle size distribution, size reduction and classification of solid particles; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, agitation and mixing; conveying of solids.

Heat Transfer

Steady and unsteady heat conduction, convection and radiation. Thermal boundary layer and heat transfer coefficients Boiling, condensation and evaporation.Types of heat exchangers and evaporators and their process calculations, cooling towers, furnace calculations.

Mass Transfer

Fick's laws, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; Stage-wise and continuous contacting and stage efficiencies; HTU & NTU concepts.Design and operation of equipment for distillation (flash, multi-component distillation etc), absorption and stripping, leaching, liquid-liquid extraction, drying, membrane separation, humidification, dehumidification and adsorption.

Chemical Reaction Engineering

Theories of reaction rates.Kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors. Development of rate laws, Residence time distribution, single parameter model. Non-isothermal reactors. Catalysis and catalytic reactions, catalyst deactivation and regeneration, Kinetics of heterogeneous catalytic reactions

Diffusion effects in catalysis. Different type of industrial reactors - Fixed bed, fluidized bed, trickle bed, slurry bed

Instrumentation and Process Control

Measurement of process variables. Sensors, transducers and their dynamics. Process modeling and linearization. Transfer functions and dynamic responses of various systems, systems with inverse response, process reaction curve, controller modes (P, PI, and PID). Control valves; analysis of closed loop systems including stability, frequency response, controller tuning, cascade and feed forward control.

Plant Design and Economics

Principles of process economics and cost estimation including depreciation and total annualized cost, cost indices, rate of return, payback period, discounted cash flow, Interest and investment costs, taxes and insurance, material selection and equipment fabrication

Computer aided design, Optimization in process design and sizing of chemical engineering equipment's such as compressors, heat exchangers, multistage contactors, reactors etc.

Chemical Technology

Inorganic chemical industries (sulfuric acid, phosphoric acid, chlor-alkali industry). Fertilizers (Ammonia, Urea, SSP and TSP) . Natural products industries (Pulp and Paper, Sugar, Oil, and Fats)

Petroleum refining and petrochemicals. Polymerization industries (polyethylene, polypropylene, PVC and polyester synthetic fibers).

Transport Phenomena

Transport of momentum, heat and mass by molecular motion – Newton's law of viscosity, Fourier's law of heat conduction and Fick's law Transport properties – Viscosity, Thermal conductivity and Mass diffusivity One-dimensional mathematical models for transfer processes using shell balance of momentum, heat and mass. Development of general differential equations for transfer of momentum, heat and mass and their applications in solving one-dimensional steady and unsteady problems. Boundary layer theories. Turbulent transport and Interphase transport.

SAMPLE QUESTION:

Q. In petroleum refining Operations, the process used to convert paraffins and naphthenes to aromatics is
   (A) Hydrotreating
   (B) Hydrocracking
   (C) Catalytic reforming
   (D) Isomerization

Q. For obtaining a given separation in distillation column the minimum number of theoretical stages is obtained with
   (A) minimum reflux ratio
   (B) optimum reflux ratio
   (C) Total reflux
   (D) Zero reflux ratio

M Tech Electronic/ Electrical

Control System:

Mathematical modeling and representation of systems, Feedback principle, transfer function, Block diagrams and Signal flow graphs, Transient and Steady-state analysis of linear time invariant systems, Routh-Hurwitz and Nyquist criteria, Bode plots, Root loci, Stability analysis, Lag, Lead and Lead-Lag compensators; P, PI and PID controllers; State space model, State transition matrix.

Signals and Systems:

Signals and Systems Representation of continuous and discrete-time signals, Shifting and scaling operations, Linear Time Invariant and Causal systems, Fourier series representation of continuous periodic signals, Sampling theorem, Applications of Fourier Transform, Laplace Transform and z-Transform

Electric & Hybrid vehicles

Introduction of electric & hybrid vehicles, Architecture and control of HEVs, Power Electronics in HEVs, Battery chargers for EVs & PHEVs.

Battery Management Systems

Application of power electronics in rechargeable batteries, Battery charge management, Cell balancing, SOA of battery power electronics.

Electric Drives

Introduction to electric drives, characteristics, advantages, speed control methods of drives.

Renewable energy sources

Introduction, advantages, their effect on environment, solar and wind energy.

Network Theory

Network graph, KCL, KVL, Node and Mesh analysis, Transient response of dc and ac networks, Sinusoidal steady-state analysis, Resonance, Passive filters, Ideal current and voltage sources, Thevenin's theorem, Norton's theorem, Superposition theorem, Maximum power transfer theorem, Two-port networks, Three phase circuits, Power and power factor in ac circuits.

Power Electronics

Characteristics of semiconductor power devices: Diode, Thyristor, Triac, GTO, MOSFET, IGBT; DC to DC conversion: Buck, Boost and Buck-Boost converters; Single and three phase configuration of uncontrolled rectifiers, Line commutated thyristor based converters, Bidirectional ac to dc voltage source converters, Issues

of line current harmonics, Power factor, Distortion factor of ac to dc converters, Single phase and three phase inverters, Sinusoidal pulse width modulation.

Programming Language

Basics of C and C++, programming in C, Programming in C++

Power System

Power generation concepts, ac and dc transmission concepts, Models and performance of transmission lines and cables, Series and shunt compensation, Electric field distribution and insulators, Distribution systems, Per-unit quantities, Bus admittance matrix, Gauss Seidel and Newton-Raphson load flow methods, Voltage and Frequency control, Power factor correction, Symmetrical components, Symmetrical and unsymmetrical fault analysis

Machine

DC machine, induction machine, alternator, transformer: principles, characteristics and applications

SAMPLE QUESTION:

Q. The induction of a power transmission line increases with
   a. Decrease in the line length
   b. Increase in diameter of conductor
   c. Increase in spacing between the phase conductors
   d. Increase in load current carried by the conductors

Q. The hysteresis loop of magnetic material has an area of 5 cm^2 with the scales given as 1 cm = 2AT and 1 cm =50mwb. At 50 Hz the total hysteresis loss is
   e. 15w
   f. 20w
   g. 25w
   h. 50w

M Tech Mechanical Engineering

Tribology of engine lubricants

Basic concepts of Applications of lubricant, Thick and thin lubrications, Lubrication mechanisms, Properties of Lubricants, Lubricant Additives

Basic and applied thermodynamics

Zeroth Law, Fundamental Concepts of thermodynamics, Different Kind of Energies, First and second laws of thermodynamic -their Corollaries. Concept of entropy, Availability, irreversibility and Available Energy. Properties of Pure Substances. Gas power cycles and performance of Internal combustion engines.

Solar energy

Solar energy systems, solar thermic fluids & their properties

Heat transfer:

Basic modes of heat transfer and their governing equations. Mechanisms of conduction convection and radiation. Heat exchangers – effectiveness, overall heat transfer coefficient, compact heat exchangers. Heat transfer of solar thermic fluids

Nano technology for engineering applications

Nano materials, their special properties and Nano technology for engineering applications

SAMPLE QUESTION:

Q. Sensible heat is the heat required to
   a) Increase the temperature of a liquid
   b) Change liquid into vapor
   c) Change vapor into liquid
   d) Convert water into steam and superheat it

Q. Wear and tear of engine is caused due to
   a) Gravity of moving parts
   b) Density of the moving parts
   c) Friction between moving parts
   d) Magnetic force