Mumbai University
Syllabus for PET 2020 Examination
Chemical Engineering

Section A: Research Methodology and General Awareness

General Awareness

General Aptitude
Verbal Ability: English grammar, sentence completion, verbal analogies, word groups, instructions, critical reasoning and verbal deduction.

Numerical Ability: Numerical computation, numerical estimation, numerical

Engineering Mathematics
***Linear Algebra*:** Matrix Algebra, Systems of linear equations, Eigen values and Eigen vectors.

***Calculus*:** Functions of single variable, limit, continuity and differentiability, mean value theorems, evaluation of definite and improper integrals, partial derivatives, total derivative, maxima and minima, gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals. Theorems of Stokes, Gauss and Green.

***Differential equations*:** First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

***Numerical Methods*:** Numerical solution of linear and nonlinear algebraic equations, integration by trapezoidal and Simpson rule, single and multi-step methods for differential equations.

Research Methodology

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific methods, understanding the language of research, Concept, Construct, definition, Variable. Research Process

Qualitative and Quantitative Research: Qualitative research, Quantitative research, concept of measurement, causality, generalization, replication. Merging the two approaches. Types of data and data collection techniques

Measurement: Concept of measurement -what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement –Nominal, Ordinal, Interval, Ratio.

Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample –Practical considerations in sampling and sample size.

Data Analysis: Data Preparation –Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis –Cross tabulations and Chi square test including testing hypothesis of association, Analysis of Variance (ANOVA)

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Section B: Chemical Engineering

Process Calculations and Thermodynamics (weightage 15%)

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 Particle size (weightage 10%)

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 (weightage 15%)

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. Design of double pipe, shell and tube heat exchangers, and single and multiple effect evaporators.

Mass Transfer (weightage 15%)

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, absorption, leaching, liquid-liquid extraction, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering (weightage 15%)

Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time distribution, single parameter model; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control (weightage 10%)

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 (weightage 10%)

Principles of process economics and cost estimation including depreciation and total annualized cost, cost indices, rate of return, payback period, discounted cash flow, optimization in process design and

sizing of chemical engineering equipments such as compressors, heat exchangers, multistage contactors.

Chemical Technology (weightage 10%)

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).

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