

# Syllabus for UPSC Indian Forest Services Examination

## Chemical Engineering Paper II

The Scope of the Syllabus for optional subject papers for the examination is Broadly of the Honours Degree level i.e. A level Higher than the Bachelors Degree and lower than the Masters Degree. In the case of Engineering subjects, the level corresponds to the Bachelors Degree.

There will be no practical examination in any of the subjects.

### Optional Subjects

**Total number of questions in the question papers of optional subjects will be eight. All questions will carry equal marks. Each paper will be divided into two parts, viz. Part A and Part B, each part containing four questions. Out of eight questions, five questions are to be attempted. One question in each part will be compulsory. Candidates will be required to answer three more questions out of the remaining six questions, taking at least one question from each Part. In this way, at least two questions will be attempted from each Part i.e. one compulsory question plus one more.**

### Paper-II

#### Section A

#### (a) Material and Energy Balances

Material and energy balance calculations in processes with recycle/bypass/purge. Combustion of solid/liquid/gaseous fuels, stoichiometric relationships and excess air requirements. Adiabatic flame temperature.

#### (b) Chemical Engineering Thermodynamics

Laws of thermodynamics. PVT relationships for pure components and mixtures. Energy functions and inter-relationships - Maxwell's relations. Fugacity, activity and chemical potential. Vapour-liquid equilibria, for ideal/non-ideal, single and multi component systems. criteria for chemical reaction equilibrium, equilibrium constant and equilibrium conversions. Thermodynamic cycles - refrigeration and power.

#### (c) Chemical Reaction Engineering :

Batch reactors - kinetics of homogeneous reactions and interpretation of kinetic data. Ideal flow reactors - CSTR, plug flow reactors and their performance equations. Temperature effects and run-away reactions. Heterogeneous reactions - catalytic and non-catalytic and gas-solid and gas-liquid reactions. Intrinsic kinetics and global rate concept. Importance of interphase and intraparticle mass transfer on performance. Effectiveness factor. Isothermal and non-isothermal reactors and reactor stability.

## Section B

### **(d) Chemical Technology**

Natural organic products - Wood and wood-based chemicals, pulp and paper, Agro industries - sugar, Edible oils extraction (including tree based seeds), Soaps and detergents. Essential oils - Biomass gasification (including biogas). Coal and coal chemical. Petroleum and Natural gas- Petroleum refining (Atmospheric distillation/cracking/reforming) - Petrochemical industries - Polyethylenes (LDPE/HDPE/LLDPE), Polyvinyl Chloride, Polystyrene. Ammonia manufacture. Cement and lime industries. Paints and varnishes. Glass and ceramics. Fermentation - alcohol and antibiotics.

### **(e) Environmental Engineering and Safety**

Ecology and Environment. Sources of pollutants in air and water. Green house effect, ozone layer depletion, acid rain. Micrometeorology and dispersion of pollutants in environment. Measurement techniques of pollutant levels and their control strategies. Solid wastes, their hazards and their disposal techniques. Design and performance analysis of pollution control equipment. Fire and explosion hazards rating - HAZOP and HAZAN. Emergency planning, disaster management. Environmental legislations - water, air environment protection Acts. Forest (Conservation) Act.

### **(f) Process Engineering Economics :**

Fixed and working capital requirement for a process industry and estimation methods. Cost estimation and comparison of alternatives. Net present value by discounted cash flow. Pay back analysis. IRR, Depreciation, taxes and insurance. Break-even point analysis. Project scheduling - PERT and CPM. Profit and loss account, balance sheet and financial statement. Plant location and plant layout including piping.

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