Syllabus for Operator Trainee (Chemical)

'Professional Knowledge Test'

I) High priority topics:

A) Unit Operations:

i) Heat transfer:
Heat transfer equipment's, Mechanism of Heat transfer in Solids, liquids and gases and their applications, Heat exchangers, Coolers, Condensers, Thermal conductivity, Fourier's law, Conduction, Convection and Radiation, Temperature & Expansion of solids and liquids, Reynolds number and Nusselt number, Log mean temperature difference etc.

ii) Mass transfer:
Concept of diffusion, rate of diffusion in mass transfer, mass transfer coefficient, Fick's law, Maxwell law, Extraction, Absorption & Stripping, Screening, Filtration, Evaporation, Humidification & dehumidification etc.

iii) Distillation:
Methods- Flash distillation, Differential distillation, Batch distillation, Vacuum & Steam distillation, Azeotropic & Extractive distillation.
Types of Distillation Columns- Perforated plate or Sieve plate column, Bubble cap plate column, Packed column & fractionating columns, relative volatility etc.

iv) Drying:
General drying behavior-Critical moisture content, equilibrium moisture contents, Description and construction of Dryer.
Types of Dryers- Tray dryer, Screen conveyor dryer, Rotatory dryer.

B) Unit Processes:

i) Process technology:
Manufacturing process description, Flow sheet, Raw materials, Chemical reactions & energetics of Plant processes such as Synthesis gas, Nitric acid, Sulfuric acid, Reformer process, Boilers and Waste heat boilers, Steam generation process, Explosives, Pesticides, Sewage and Effluent treatment, Crushing and Grinding equipment's, etc.

ii) Ideal Reactors & Cooling Towers:
Classification and types of Reactors such as Batch reactor, Semi-batch reactor, Continuous reactor etc.
Description of Cooling towers, their types, construction, working and efficiency in fertilizer industries.

iii) Fertilizer technology:
Detailed manufacturing of fertilizers such as Nitrogenous (Ammonia, Urea), Phosphatic, (Superphosphate and triple superphosphate), Potassic (potassium chloride, potassium sulfate), Mixed, (a mixture of ammonium phosphate ammonium sulfate and potash), Micro nutrients (Different types of micronutrients and their effects), Bio-fertilizers (Various types of bio-fertilizers).

iv) Industrial technology:
Cracking, reforming, alkylation, isomerization, hydrogenation, oxidation, nitration, sulfonation, polymerization, catalysis etc.
Definition, properties and uses of flash point, fire point, cloud and pour point, viscosity index, octane number, cetane number, smoke point, penetration number.

C) Fluid Mechanics:

i) Properties of fluids, types of flow, Flow of fluid through pipes and its measurements.

ii) Construction, working, efficiency & functions of different types of Pumps and their power requirements.

iii) Construction, working, types & uses of Valves, Control valves, NRV, ON/OFF valves etc.

iv) Compressors- Definition, types, functions and uses.

D) Process Control & Instrumentation:

i) Pressure, Level, Flow etc. measuring instruments.

ii) Sensors, Transmitters, Gas analyzers.

iii) Closed loop, Open loop, DCS, PLC and other control systems.

iv) Plant safety inter-locks.

E) Occupational Health & Safety and Environmental education:

i) Industrial accidents & Personal protective equipment's (PPE):
   a) Types and causes of accidents, Accident prevention methods.
   b) Need and types of PPE, Respiratory protection equipment's etc.

ii) Fire & Electrical Safety:
   a) Causes of Fire, Fire triangle, Classification of Fire, Types of Fire extinguishers, Fire prevention and control.
   b) Electrical hazards, Safe working practices, Overloading & short circuit, First aid for electric shock.

iii) Pollution & Chemical safety:
   a) Water and Air pollution- Types, effects and control.
   b) Chemical hazards, Labels of MSDS, Safety precautions while handling acids, alkalis, gases etc.

iv) First Aid & Safety signs & Housekeeping:
   a) First aid for burns, eye injuries etc.
   b) 5S concept, types of safety signs and symbols.

F) Fuels and combustion:

i) Solid Fuels:
Coal (types: peat, lignite, bituminous, anthracite), wood, coke, briquettes.

ii) Liquid Fuels:
Petroleum, gasoline (petrol), diesel, kerosene, fuel oil, biodiesel, alcohol.

iii) Gaseous Fuels:
Natural gas, liquefied petroleum gas (LPG), CNG, coal gas, water gas, producer gas.

G) Fuel Analysis and Properties:

i) Proximate Analysis:
Moisture content, volatile matter, ash content, fixed carbon.

ii) Ultimate Analysis:
Elemental composition (Carbon, Hydrogen, Oxygen, Nitrogen, Sulphur).

iii) Calorific Value:
Gross Calorific Value (GCV), Net Calorific Value (NCV), determination using Bomb Calorimeter.

iv) Fuel Characteristics:
Ignition temperature, flash point, fire point, pour point, viscosity.

H) Combustion Fundamentals:

i) Combustion Types:
Rapid, spontaneous, and explosion.

ii) Chemistry of Combustion:
Chemical reaction, Stoichiometric air-fuel ratio, excess air calculations.

iii) Products of Combustion.

iv) Efficiency & Control:
Complete vs. Incomplete combustion, Flue Gas Analysis (Orsat apparatus), air-fuel ratio management

II) Low priority topics:

A) Introduction to Chemistry:

i) Atomic structure-Electrons, Protons, Neutrons, Electronic theory of valency, Periodic trends in properties of elements.
ii) Gas laws, Ideal gas equation, Henry's law, Raoult's law etc.
iii) Allotropic forms of Carbon, Phosphorus, Sulphur etc.
iv) Nomenclature of Organic compounds.

B) Basic Science:

i) Homogeneous Reactions:
Rate of chemical reaction, factors affecting rate of a reaction, Rate constant, Elementary and non-elementary reactions, Order of a reaction, Molecularity of a reaction, Catalyzed and un-catalyzed reactions etc.

ii) Chemical Thermodynamics:
Basic concepts and terms used in Thermodynamics, Temperature and Heat, Laws of thermodynamics, Thermodynamic processes.
Thermodynamic properties- Internal energy, Enthalpy, Entropy etc.

C) Units, Measurements & Calculations:

i) Unit system and Fractions:
Classification-Fundamental and Derived units, Factors, HCF & LCM.
Fractions-Addition, Subtraction, Multiplication, Division, Decimal fractions etc.
Calculations of Pressure, Volume, Mass, Density, Mole fraction etc.

ii) Material Science:
Types of metals, Types of ferrous and non-ferrous alloys, Physical and mechanical properties of metals etc.

D) Quality Tools:

i) Quality Consciousness & Quality Circles:
Meaning of Quality, Roles and function of Quality Circles in Organization, Operation of Quality Circle etc.
ii) Quality Management System:
Knowledge of ISO-9001, ISO-14001, ISO-45001 (OHSAS 18001) and their importance in maintaining qualities.
Role of TQM (Total Quality Management) in industries.