

Nepal Engineering Council Registration Examination

High Tech Plasma and Plants Engineering Syllabus (AHtE)

Chapters 1-4 are fundamentals/principles of concepts in High Tech Plasma and Plants Engineering; chapters 5-9 are related to application of engineering principles in practice; and the last (10th) chapter is related to project planning, design and implementation.

1 The Kinetic Theory of Gases (AHtE01)

- 1.1 **Introduction:** Plasma as Ionized Gas, Plasma as Quasi-Neutral, Basic Processes in Gas, Generation and Measurement of Plasma, Mass Properties of Plasma, Comparison of Properties of Gases and Plasmas. (AHtE0101)
- 1.2 **Atomic/Molecular Process in Plasma:** Physical Phenomena in Weakly Ionized Plasma, Plasma Shielding (Elementary Derivation of The Boltzmann Distribution, Plasma Density in Electrostatic Potential, Debye Shielding, Plasma Solid Boundaries) (AHtE0102)
- 1.3 **The ‘Plasma Parameter’:** Occurrence of Plasmas, Different Descriptions of Plasma, Equations of Plasma. (AHtE0103)
- 1.4 **Basic equations:** Klimontovich Equation, Liouville Distribution, BBGKY Hierarchy, Vlasov’s Equation, Maxwell’s Equation, Liouville’s Theorem, Boltzmann’s Equation, Saha Equation. (AHtE0104)
- 1.5 **Maxwell-Boltzmann Distribution Function:** Velocity Distribution Functions, Energy Distribution Functions, Particle Collisions, (Elastic Binary Collisions, Inelastic Binary Collisions, Heterogeneous Interactions at Surfaces, Plasma Collisionality Regimes). (AHtE0105)
- 1.6 **Kinetic Characteristics:** The Hard-Sphere Model, Collisional Parameters, Particle Flux on A Surface, Power Flux on A Surface, Direct Transport Phenomena, Diffusive Particle Transport, Momentum Transport, Energy Transport Charge Transport. (AHtE0106)

2 Characteristics of Plasma (AHtE02)

- 2.1 **Charged Particle Motion in Steady Electric and Magnetic Fields:** Charged Particle Motion in Slowly Varying Electric or Magnetic Fields, Relativistic Charged Particle Motion, Theory of Planar Diodes, Relativistic Planar Diode. (AHtE0201)
- 2.2 **Bulk Properties of Plasma:** Electrical Resistivity and Conductivity, Mobility, Ohmic Heating of Plasmas, Energy Transfer Frequency, Ohm’s Law and Body Forces in Magnetized Plasmas. (AHtE0202)
- 2.3 **Quasi-Neutrality of Plasma:** Electrostatic Boltzmann (Barometric) Equation, Simple Electrostatic Plasma Sheaths, Plasma Frequency. (AHtE0203)
- 2.4 **Fick’s Law of Diffusion:** Containment Time in A Diffusion-Dominated Plasma, Diffusion Coefficient in An Unmagnetized Plasma, Classical Diffusion in a Magnetized Plasma. (AHtE0204)
- 2.5 **Mobility in A Magnetized Plasma:** Einstein’s Relation, Bohm Diffusion Coefficient, Ambipolar Diffusion. (AHtE0205)
- 2.6 **Low Pressure Electrical Discharge:** Classical Geometry, Voltage-Current Characteristic, Plasma Power Supplies, Power Supply Frequency Regimes, Power Supply Availability, Power Supply Technology, Relative Cost of Input Power, Operational Constraints. (AHtE0206)

3 Electron Sources and Beams, Ion Sources and Beams(AHtE03)

- 3.1 **Thermionic Emission:** Richardson Equation, Photoelectric Effect, Photoelectron Current Densities, Field Emission Sources (AHtE0301)
- 3.2 **Hollow Cathode Sources:** Alternative Configurations, Foil-Enhanced Hollow Cathodes, Secondary Electron Emission Sources, Source and Beam Characteristics, Beam Parameters, Figures of Merit for Electron Sources(AHtE0302)
- 3.3 **Charged Particle Beam Transport:** Source Requirements, Current Density Enhancement, Electrostatic Beam Deflection, Magnetic Beam Deflection, Comparative Deflection Capabilities, Paraxial Beam Transport(AHtE0303)
- 3.4 **Characteristics of Ion Sources:** Figures of Merit of Ion Sources, Ion Source Performance Parameters (AHtE0304)
- 3.5 **Ion Source Design:** Electrode Lifetime Limits, Power Deposition Limits, Design Optimization, Kaufman Ion Source, Basic Configuration, Alternative Configurations, Operating Characteristics (AHtE0305)
- 3.6 **Penning Discharge Sources:** Penning Configuration, Ion Heating in Penning Sources, Other Penning Configuration, Beam-Plasma Ion Sources, Capillary Arc Source, Perpendicular Beam-Plasma Ion Source, Parallel Beam-Plasma Ion Source, Von Ardenne Ion Sources, Freeman Ion Source, Surface Ionization Sources (AHtE0306)

4 Electrical Discharge in Gases (AHtE04)

- 4.1 **Dark Electrical Discharges in Gases:** Introduction, Saturation Regime, Townsend Discharge, Corona Discharges, Corona Sources, Electrical Breakdown, A Universal Paschen Curve (AHtE0401)
- 4.2 **Dc Electrical Glow Discharges in Gases:** Phenomenology of Dc Glow Discharges, Theory of Dc Glow Discharges, Theory of Moving Striations, Theory of Dc Plasma Sheaths, Dc Glow Discharge Plasma Sources, Characteristics of Glow Discharge Reactors, Issues in Glow Discharge(AHtE0402)
- 4.3 **Dc Electrical Arc Discharges in Gases:** Arc Regime, Phenomenology of Electrical Arcs, Physical Processes in Electrical Arcs, Examples of Arc Operation, Power Supplies For Electrical Arcs, Initiating Mechanisms For Arcs, Applied Arc Configurations, Issues in Arc (AHtE0403)
- 4.4 **Inductive RF Electrical Discharges in Gases:** Introduction, Phenomenology of RF-Plasma Interactions, Skin Depth of Plasma, Inductive Plasma Torch, Other Methods of Generating Inductive Plasmas(AHtE0404)
- 4.5 **Capacitive RF Electrical Discharges in Gases:** Unmagnetized RF Electrical Discharges, Magnetized RF Electrical Discharges, Theory of RF Plasma Sheaths, Capacitively Coupled RF Plasma Sources, Types of Capacitive RF Plasma Reactors, Issues in Capacitively Coupled Plasma Sources(AHtE0405)

- 4.6 **Microwave Electrical Discharges in Gases:** Introduction, Electromagnetic Propagation in The Collective Regime, Microwave Breakdown of Gases, Electron Cyclotron Resonant Microwave Plasma Sources, Non-Resonant Microwave Plasma Sources (AHtE0406)
- 5 Surface Interactions in Plasma Processing (AHtE05)**
- 5.1 **Industrial Plasma Processing:** Industrially Significant Plasma Characteristics, Benefits of Plasma Processing, Conventional and Plasma Surface Treatment of Wool, Toxic waste Production in The Microelectronic Industry, Relevant Size Scales (AHtE0501)
- 5.2 **Plasma Active Species:** Species Reaching Surface, Photons, Neutral Species, Charged Particles (AHtE0502)
- 5.3 **Heterogeneous Interactions with Surfaces:** Heterogeneous Interactions in Plasma Processing, Characteristic Heterogeneous Interactions, Energetic Particle-Induced Surface Chemistry, Heterogeneous Reactions of Ions with Surfaces, Reflection and Trapping on Surfaces(AHtE0503)
- 5.4 **Secondary Electron Emission:** Secondary Electron Emission Coefficient, Effect on Collected Current, Characteristic Data(AHtE0504)
- 5.5 **Sputtering:** Definitions, Functional Dependence of ϵ , Features of Sputtering Yield Curves, Angular Dependence of Sputtering Yield, Phenomenological Sputtering Yield, Erosion(AHtE0505)
- 5.6 **Ion Implantation in Solids:** Ion Implantation Methods, Physical Processes in Ion Implantation, Ion Interaction Regimes(AHtE0506)
- 6 Atmospheric Pressure and Vacuum Plasma Sources (AHtE06)**
- 6.1 **Characteristics of Plasma Sources:** Plasma Type, Operating Pressure, Power Supply Characteristics, Plasma Interaction with Workpiece, Problematical Plasma Source Nomenclature, Plasma Source Applications (AHtE0601)
- 6.2 **Atmospheric Pressure Corona Sources:** Atmospheric Dielectric Barrier Discharges, The One Atmosphere Uniform Glow Discharge Plasma(AHtE0602)
- 6.3 **Arc jet Plasma Sources:** Inductively Coupled Plasma Torches(AHtE0603)
- 6.4 **Intermediate-Pressure Plasma Sources:** Parallel-Plate Sources, Magnetron Plasma Sources, Continuous-Flow Inductively Coupled Plasma Sources(AHtE0604)
- 6.5 **Low-Pressure Plasma Sources:** The Electron Bombardment Plasma Source, Microwave Plasma Sources, Planar-Coil Inductive Plasma Sources, The Helicon Plasma Source(AHtE0605)
- 6.6 **High-Vacuum Plasma Sources:** Summary of Plasma Source Parameters(AHtE0606)

7 Plasma Reactors for Plasma Processing (AHtE07)

- 7.1 **Plasma Reactors for Surface Treatment:** Plasma Reactors for Films, Webs and Fibers, Plasma Reactors for Three-Dimensional Workpieces, Atmospheric-Pressure Surface Treatment Reactors, Intermediate-Pressure Glow Discharge Reactors, Operational Issues (AHtE0701)
- 7.2 **Plasma Reactors for Ion Implantation:** Reactors for Low-Energy Plasma Thermal Diffusion Treatment, Reactors for Plasma Ion Implantation(AHtE0702)
- 7.3 **Reactors for Ion-Beam-Induced Sputter Deposition:** Ion-Beam-Induced Sputter Deposition Reactors, Reactor System for Ion-Beam-Induced Sputtering(AHtE0703)
- 7.4 **Plasma/Cathode Sputter Deposition Reactors:** Parallel-Plate Configurations, Planar Magnetron Configurations, Axisymmetric Magnetron Configurations, Cylindrical Magnetron Configurations(AHtE0704)
- 7.5 **Reactors for Plasma Chemical Vapor Deposition:** Non-Polymeric PCVD Reactor Systems, Polymeric PCVD Reactor Systems(AHtE0705)
- 7.6 **Plasma Etching Reactors:** Plasma Etching Reactor Systems, Plasma Etching Reactor Subsystems(AHtE0706)

8 Operation and Management of Plant Engineering(AHtE08)

- 8.1 **Objectives and Philosophy:** The Plant Engineering Organization, Principles and Philosophy, Types of Maintenance Management, Planning and Controls (AHtE0801)
- 8.2 **Plant Management:** Electric Systems Management, Water Purification and Treatment, Water Cooling Systems, Applications of Heating, Ventilating and Air-Conditioning Systems, Communication and Computer Networks (AHtE0802)
- 8.3 **Materials Handling:** Planning, Containerization, Fixed-Path Equipment, Mobile Equipment, Warehousing and Storage(AHtE0803)
- 8.4 **Waste management:** Liquid-Waste Disposal, Solid-Waste Disposal, Energy Conservation(AHtE0804)
- 8.5 **Fire Protection and Prevention:** Toxic Substances and Radiation Hazards, Sanitation Control and Housekeeping(AHtE0805)
- 8.6 **Pollution control:** Air Pollution Control, Noise Control, Vibration Control, (AHtE0806)

9 Prime Movers for Power Generation and Cogeneration (AHtE09)

- 9.1 **Electric Measuring Instruments:** Building Air Quality, HVAC System Control Equipment (AHtE0901)
- 9.2 **Mechanical Equipment:** Gearing and Enclosed Gear Drives, Rolling Element Bearings, Shaft Drives and Couplings (Part 1 Flexible Shafts, Part 2 Belt Drives, and Part 3 Chain Drives) AHtE0902)

- 9.3 **Electrical equipment:** Electric Motors, Electric Motor Controls, Lighting, Computers, Power Distribution Systems, Standby and Emergency Power, Rotating Equipment Systems, Batteries AHtE0903)
- 9.4 **Plastics Piping:** Pipe Insulation, Corrosion Control, Valves, Lubricants: General Theory and Practice AHtE0904)
- 9.5 **Thermal equipment:** Boilers, Fuel and Combustion Equipment, Electric Generators AHtE0905)
- 9.6 **Engines:** Gas Turbines and Steam Turbines, Diesel and Natural Gas Engines AHtE0906)

10. Project Planning, Design and Implementation

(AALL10)

10.1 Engineering drawings and its concepts: Fundamentals of standard drawing sheets, dimensions, scale, line diagram, orthographic projection, isometric projection/view, pictorial views, and sectional drawing.

(AALL1001)

10.2 Engineering Economics: understanding of project cash flow; discount rate, interest and time value of money; basic methodologies for engineering economics analysis (Discounted Payback Period, NPV, IRR & MARR); comparison of alternatives, depreciation system and taxation system in Nepal.

(AALL1002)

10.3 Project planning and scheduling: project classifications; project life cycle phases; project planning process; project scheduling (bar chart, CPM, PERT); resources levelling and smoothing; monitoring/evaluation/controlling.

(AALL1003)

10.4 Project management: Information system; project risk analysis and management; project financing, tender and its process, and contract management.

(AALL1004)

10.5 Engineering professional practice: Environment and society; professional ethics; regulatory environment; contemporary issues/problems in engineering; occupational health and safety; roles/responsibilities of Nepal Engineers Association (NEA).

(AALL1005)

10.6 Engineering Regulatory Body: Nepal Engineering Council (Acts & Regulations).

(AALL1006)