ADVANCED DIPLOMA IN FOUNDRY/ FORGE TECHNOLOGY.

Basic structure of the Course

1st Semester

(DURATION: One and half years (3 Semesters))

(Common to both Foundry Technology & Forge Technology)

Sl. No.	Course Subject	Deptt. Offering	Hours			No. of credits
			L	T	P	
1.1	Engineering Science		3	0	2	4
1.2	Engineering Mechanics		3	1	0	4
1.3	Introduction to Materials Engineering		3	0	2	4
1.4	Physical Metallurgy		3	0	2	4
1.5	C. A. D. (Engineering drawing)		2	0	2	3
1.6	Metal Shaping Processes		3	0	2	4
1.7	English Communication		2	0	2	3
		Total				26

2nd Semester
(Foundry Technology)

Sl. No.	Course Subject	Deptt. Offering	Hours			No. of credits
			L	T	P	
2. 1	Foundry Tooling & Methoding		3	0	2	4
2.2	Foundry Processes		3	0	2	4
2.3	Non-Ferrous Casting Production		3	0	2	4
2.4	Iron & Steel Casting Production		3	0	2	4
2.5	Metrology, Inspection & Quality Control		3	0	2	4
2.6	Industrial Engineering & Management		2	1	0	3
2.7	Heat Treatment Technology (Elective)		2	0	2	3
		Total				26

Elective Subject:-

Foundry Technology

(a) Precision casting process
(b) Heat Treatment Technology
(c) Production Management
(d) Welding & Salvaging Processes

2nd Semester
(Forge Technology)

Sl. No	Course Subject	Deptt. Offering	Hours			No. of credits
			L	T	P	
2.1	Technology of Free Forging		3	0	2	4
2.2	Technology of Closed Die Forging		3	0	2	4
2.3	Forging Die Design & Manufacture		3	0	2	4
2.4	Metrology, Inspection & Testing		3	0	2	4
2.5	Forging of non-ferrous & Special Alloys (Elective)		3	0	2	4
2.6	Heat Treatment of Technology		2	0	2	3
2.7	Industrial Engineering & Management		2	1	0	3
		Total				26

Elective subjects:-

Forge Technology

(a) Forging of non-ferrous & Special Alloys
(b) Friction& Lubrication in Forging
(c) Rolling Extrusion and Sheet Metal Working
(d) Welding

Semester III

In plant Training in Foundry & Forge Industries		:	04	Credits
Project work		:	10	Credits
General performance & Viva-voce		:	02	Credits
Seminar		:	02	Credits
	Total	:	18	Credits

Total Credits

1st Sem.		2nd Sem.		3rd Sem.		Total
26	+	26	+	18	=	70

1st Semester (Common to Foundry Technology and Forge Technology)

Engineering Science (3 – 0 – 2)

Magnetism, magnetic properties of materials, their dependence on temperature and composition, methods of magnetization and demagnetization, typical industrial applications, Principle of electromagnetic induction and industrial application in induction heating and melting, Alternating currents: generation, properties and application.

Electronics, thermal and photoelectric emission, rectifiers, amplifiers and relays; industrial applications.

Thermoelectric effects : Seeback, Peltier &Thompson effect X-rays: generation, continuous & characteristics radiation, Vacuum tubes target and anode, intensities of X-ray beams, effects of voltage &amperage, absorption of X-ray and use of filters.

Radioactivity : natural &artificial radio activity, alpha, beta, gamma particles & their characteristics, isotopes, half life period.

Atomic structure and Periodic Table Precipitation, Co-precipitation & post-precipitation. Oxidation & Chemistry of engineering materials with particular reference to castings & forgings; Metals & alloys; fluxes, Sands&clays etc. & their chemical assaying. Emission spectroscopy; origin of spectra, principle of visual spectrograph and direct reading spectrograph. Methods of Qualitative & Quantitative analysis.

Engineering Mechanics (3 – 1 – 0)

Fundamental concepts and principles; Introduction to SI units; Review of vector Algebra; Important vector quantities;

Statics of particles: Concept of force; resultant of forces; resolution of forces; Equilibrium of particle. Statics of rigid bodies: Definition of rigid body; Dot product and cross product of two vectors; mixed triple product of three products; Moment and couple; Varignon’s theorem;

Equivalent system of forces; simplest resultants; Equilibrium of rigid bodies. Analysis of structures: determination of forces in members of plane trusses by method of joints and sections. Friction: the law of dry friction; wedges; square threaded power screws; belt friction. Properties of surface; Centroids and centers of gravity of areas and lines, volumes;

Theorems of Pappus Guldinus; Second moment of Inertia, of an area; Polar moment of inertia; Parallel axis theorem. Kinematics of particles: Position, velocity and acceleration of a particle in rectilinear and curvilinear motion; Relative motion; Motion of projectiles; Tangential and normal components of acceleration. Kinetics of particles: Newton’s second law of motion; Equation of motion; Dynamic equilibrium. Kinematics of rigid bodies: Introduction; Translation; Rotation about a fixed axis; General plane motion; Absolute and relative velocity in plane motion; Plane motion of a particle relative to a rotating frame Corriolis acceleration; Motion about a fixed point; General Motion

Pressure exerted by liquids, centre of pressure, transmission of fluid pressure and Pascal's law Fluid in motion, viscosity and concepts of stream lime and turbulent flow, Bernoulli's theorem, surface tension and capillarity, application to gating and feeding of castings.

Introduction to Materials Engineering (3 – 0 – 2)

Fuels : classification of fuels; Solid, Liquid and Gaseous, Natural and Synthetic liquid fuels, their advantages and disadvantages, Principles of combustion , calorific value, speed and combustion, requirements of air or oxygen, properties or flames, combustion problems. Non-conventional energy.
Furnaces : Classification based on heating methods and Refractories used, Basic principles of fuel fired resistance, induction and arc furnaces; furnaces lining.
Furnace atmospheres, furnace efficiency, typical examples in foundry and forge industries. Environmental pollution: air ,water soil and noise, effect of pollution on human, pollution control measures.
Refractories : classification of Refractories, their manufacture, properties and uses in foundry and forge industries.

Physical Metallurgy (3 – 0 – 2)

Crystal structures of Metals and Alloys, Phase diagram and Lever rule, Different types of alloy phase diagram, Nucleation and Growth, Solidification and its Problems, Diffusion in Solids, Strengthening of metals and alloys.
Metallurgical Microscope, techniques for microscopic observation, characteristic of alloy microstructure. Brief idea about standard &non ferrous microstructure.
Heat treatment of Steel : T-T-T diagram, Annealing, Normalizing, Hardening and Tempering of steels, Austempering, Surface hardening processes-case carburizing and Case Nitriding etc. Precipitation hardening, new techniques of heat treatment.

CAD (Engineering Drawing) (2 – 0 – 2)

Drawing standards, dimensioning and notes; orthographic projections; isomeric projections and Isometric views of solids and combination of solids; sectioning; assembly concepts; assembly drawing. Introduction to computer aided drafting using commercial packages.

Introductions to 3D modeling; 3-D modeling of molds &forging dies using solid modeler; Simulation and analysis of close die forging of forged components, such as gear blank using FEM based software packages. Simulation of metal flow in moulds, effects of methoding solidification, in castings using industry standard FEM based software packages.

Metal Shaping Processes (3 – 0 – 2)

Comparison and application of various metal shaping processes, Basic steps in casting production, materials and types of patterns, Conventional, molding and core making practice. Routine sand testing, Methoding, Melting and Casting practices; Common casting defects.
Metal-working process; Classification, principles; merits, demerits and application of different conventional forming processes viz, forging, rolling, extrusion, drawing and sheet metal forming; Effect of speed, deformation and metallurgical structure during forming, Formability tests and criteria. Various fpeof welding and fabrication process and their applications; welding of various metals and alloys; weldability.
Introduction to the conventional machine tools, mechanics of metal cutting, cutting tool materials and tool geometry. Introduction to CNC machine Metal removal process such as ECM, EDM & AJM and their applications.

English Communication (2 – 0 – 2)

Fundamental of English language based graffLma1 writing correct simple sentences, vocabulary building, comprehension. Introduction to English sound patterns, spoken English, preparing for interview & comprehension.
Short stories &essays to with a view to improving the communication skills & expression in English.

2nd Semester (Foundry Technology)

2.1 Foundry Tooling & Methoding (3 – 0 – 2)

Pattern materials; wood, manufactured timber, metals, plaster, plastics, rubbers, & their characteristics & criteria for selection. Types of pattern equipment; types of Construction :Use and types of core prints; pattern accessories; pattern allowances and their selection; pattern layouts & material required. Pattern making hand tools and machinery; pattern coatings storage & Repair of patterns. Principle of solidification of castings; Elements of gating system. Design of gating systems: gating ratio; pressurized and un- pressurized systems; types of gates; Slag traps and filters etc. with reference to different cast metals and alloys. Design of feeding systems :- Directional and progressive solidification; design and positioning of feeders; feeding range and controlled directional solidification; feeding efficiency. Principles of casting design.

2.2 Mould-core materials & Processes (3 – 0 – 2)

Sand : Occurrence, classification and characteristics of different types of Sand; grain size, Shape and distribution and its effect on properties.
Binders : Clay, linseed oil, dextrin, sodium silicate; molasses; their characteristics &quality tests. Moulding Practices : Green &dry sand practices, carbon dioxide &shell processes, oddside, three part, loams, sweep &pit moulding, skeleton patterns, stack moulding, and core assembly. Role and function of additives and washes in conventional mouldand core making processes. Core making practices :For small and large cores, swept cores, loam cores, skeleton core boxes, mould and core ,ventting, reinforcement and drying. Machines for sand mixing and preparation of mouldsand cores like mixer, muller, jolting, squeezing, jolt squeezing, slinging, blowing and shooting and their function and characteristics. Core locations, closing weighting of moulds. Sand reclamation methods and equipments. Casting defects mainly attributed to moulding and core making practices and materials.

2.3 Non-Ferrous Casting Production (3 – 0 – 2)

Composition, solidification, structure, properties and application of commercially important aluminum, magnesium, copper and zinc base alloys. Charge calculation, hardeners; oxidation and gas absorption in metals and alloys; detection of gases. Melting, fluxing, degassing and pouring practices, filtration of non-ferrous melt; melt treatment for alloying modification and grain refinement. Mould and core practices, metal mould reaction, gating and feeding practices. Advanced moulding process details, ingredients used, process variables and economy of the process using sodium silicate binder and organic binder process e.g. hot box, cold box ABC, silicate ester, catalysed no-bake, warm box processes. Fluid Sand, full moulding, magnetic moulding, investment casting, frozen mould casting, vacuum sealed moulding, high pressure moulding, impact moulding explosion moulding and squeeze casting processes. Die casting, centrifugal casting and continuous casting. Defect analysis, salvaging of castings.

2.4 Iron & Steel Casting Production (3 – 0 – 2)

Significance of carbon equivalent, solidification of grey and S.G.irons, states of graphitization ,effect of alloying elements. Classification, properties and application of grey. Compacted graphite, malleable and S.G.irons. Melting units for production of cast iron and melt quality control tests. Inoculation, desulphurization and Mg treatment methods for production of S.G.iron production and malleablizing heat treatment for malleable iron. Production of compacted graphite iron. Moulding and core making processes for cast irons. Gating and feeding practices for cast iron production. Casting defects analysis.

Classification, properties and application of carbon and alloy steels. Solidification mechanism. Melting of carbon and alloy steel in electric arc and induction furnaces, acid and basic practices,
oxidation and refining, fluxing. Sulphur and phosphorous removal, de-oxidation, methods of degassing. tapping and pouring, Gating and feeding practices.
Mould and core making practices. Fettling and salvaging of castings. Heat treatment of steel castings. Defects in steel casting and their remedial measures.

2.5 Metrology, Inspection & Testing (3 – 0 – 2)

Principles of Dimensional and Form measurements. Basic standards of Length and Angle' Industrial standards. Errors in Measurement; Linear and Angular Measurements; Comparators;
Gauges; Straightness and Flatness; Measurement of screw thread; Surface Measurements; Coordinate Measuring Machines Statistical process control; economics of quality control; acceptance sampling plans and selection.
Classification of various tests on the basis of type &rate of loading. Principles of different tests viz tensile, compression, bend ,torsion, impact, hardness, toughness etc. Variables affecting these tests.
Principles, classification; testing techniques, merits, demerits &field of application; of various non- destructive tests and inspections viz, Visual inspection, Radiography, Ultrasonic, Magnetic Particle, Eddy current, Dye penetrate, Holography, Optical microscopy, Fractography Statistical parameters for quality assurance, Prediction of processes or product quality using normal distribution, Sampling inspection, Use of control charts. Applications of these tests in Foundry & Forge Industries. Case studies.

2.6 Heat Treatment Technology (2 – 0 – 2)

Alloying behavior of iron and decomposition of Austenite, Diffusionless and Diffusion controlled transformations; pearlitic, bainitic and martensitic transformations, concept of hardness and hardenability, mass effect etc. Surface and volume hardening, tempering, annealing, normalizing; Heat treatment alloy steel castings and forgings, stainless steels, Hadfield steels, spring steels, Heat treatment of cast iron, malleable iron and S.G. iron, Heat treatment of Non-ferrous metals and alloys, theory of age hardening; Heat treatment of Brasses, Bronzes, Aluminum, Titanium & Magnesium alloys forging.

2.7 Industrial Engineering & Management (2 – 1 – 0)

Introduction; major areas of application; production planning and control; types of production; prior planning, forecasting, loading, scheduling and sequencing; Inventory control, types of production, Material requirement planning.
PERT & CPM network and its uses. Operations research and its applications, Graphical method and Simplex methods of solving linear programming problems Work-study: Method study and work measurement; work sampling; applications, Project planning, costing and estimating for castings and forgings; Forms of Industrial enterprises; Human resource development; productivity of foundry &forge industries.

List of Electives:

2.8 (a) Precision Casting Process

Precision Casting Process principle process details; process variables; economics and comparative studies of precision casting processes such as shell investment casting, ceramic moulding, plaster moulding, die casting process; rheocasting, squeeze casting and centrifuging.

2.8 (b) Heat Treatment Technology

Alloying behavior of iron and decomposition of Austenite, Diffusionless and Diffusion controlled transformations; pearlitic, bainitic and martensitic transformations, concept of hardness and hardenability, mass effect etc. Surface and volume hardening, tempering, annealing, normalizing; Heat treatment alloy steel castings and forgings, stainless steels, Hadfield steels, spring steels, Heat treatment of cast iron, malleable iron and S.G. iron, Heat treatment of Non-ferrous metals and alloys, theory of age hardening; Heat treatment of Brasses, Bronzes, Aluminum, Titanium & Magnesium alloys forging.

2.8 (c) Production Management

History of industrial management; Principles of management ;management theory; Authority personnel communication; Transactional analysis; management by objectives; management information system; Basic concept of productivity; Measures of productivity; Methods of improving productivity ; Human resource development; Quality circles; Job evaluation & merit rating cost control in foundry & forge industries.

2.8 (d) Welding & Salvaging Processes

Various Welding processes suited to fabrication &repair of castings &forgings, Weldability welding energy sources & their characteristics; welding of various metals & alloys. Physical & metallurgical characteristics of Weldments, Testing & Inspection of Weldments. Salvaging of casting of forgings. Types & methods of repairs; Impregnation, metal spraying & other processes.

2nd Semester (Forge Technology)

Technology of Free Forging (3 – 0 – 2)

Design aspects of forging and their significance; Procedure of working out of forging drawing and technology, chart or route card for carbon steel and other non-ferrous alloys for hammer and presses. Allowances and tolerances for free forging with respect to Indian and foreign standards. Giving the forging and machining allowances and tolerances, developing the forging drawing of the following jobs e.g.; straight, stepped and hollow shafts, hollow vessels, hook discs ,crank shafts etc.

Different methods of blank preparation, Selection of methods for steel, non-ferrous, high speed steels and tool steels, Economic and technological considerations regarding the choice of blank

Different types of forging defects arising from ingot, bloom &billet, heating and forging method itself, with their remedies.

Dies and different types of tools used in forge shops. Characteristics of steel used for open die &tools. Die life and their improvement.

Types, working principle, specification, efficiency characteristics, choice on the basis of economical and technological considerations, operation and maintenance of following forging machines; Descaler, reduce roller, pneumatic hammers, hydraulic presses. Factors affecting the capacity of forging machines,

Working of different heating devices used in forge industries viz, Blacksmith hearths, oil & gas fired furnaces, electrical resistance heating furnaces, induction heating furnaces, radiant tube, etc.

Technology of Closed Die Forging (3 – 0 – 2)

Introduction to ferrous and non-ferrous die forgings. Preparation of process technology chart or route card. Factors affecting the metal flow in the dies; forgeability, friction and lubrication; die
temperature, Size and shape factors, etc. macroetching test for metal flow.
Survey of die forging techniques; impression die forging-blocking, distributing t}le material; hammer and press forging, forging in heated dies; Upset forging of solid and hollow bodies. Finishing operations; Trimming, punching, coining, etc.
Die forging techniques employed for making non-ferrous and special alloy forgings used for air-craft and nuclear Industries. Quantitative evaluation of die wear and factors minimizing die wear. Causes and prevention of die forging defects.
Working principle and technological considerations for the following forging machines; Drop hammer, mechanical presses, upsetter, trimming press, coining press, twisting press, etc.
Working principle, specification, characteristics of handling equipmentssuch as hand bar, tongs, self-closing crane tongs, furnace charging and discharging lever and manipulator, etc

Forging processes involving the use of electrical upsetters, orbital forging presses; Automatic horizontal forging processes and multiram forging processes. Transverse rolling. Isothermal forging, super plastic forging, Net-shape technology. Powder forging, precision forging, Flashless forging, Rheo Forging, Liquid forging, warm forging technology, long forging machine, HERF

Forging Die Design & Manufacture (3 – 0 – 2)

Study of forging drawing and its simplification from die design point of view. Determination of stock size, tensile strength of material at the finishing temper Calculation of weight of falling parts or die of a drop hammer, Mechanical press' of massive die blocks or insert dies. Grade of steel for die parts. Production of die blocks and factors controlling their quality, CAD of forging dies, Modeling and analysis of forging process using software's (Deform, etc.).
Location of parting line, Selection of flash gutter' Determination of flash thickness and volume of fin, Calculation of wall thickness and distance between two impressions' design of edger, fuller, bander, blocker, finishing impression, dovetail ,cross, key and tapered key. Low governing the design of the dies horizontal forging machine. Design of punches and heading tools for upsetter (horizontal forging machine). Determination of capacity of trimming press. Design of trimming dies; Design of punches and die clearance between punch and die. Design of stripping and clipping tools. Assembly details for trimming. Technical requirements for sinking, resinking and rectification of dies, Instruction for mounting, setting and working of dies, Reduced Roll design.

Metrology, Inspection & Testing (3 – 0 – 2)

Principles of Dimensional and Form measurements. Basic standards of Length and Angle' Industrial standards. Errors in Measurement; Linear and Angular Measurements; Comparators;

Gauges; Straightness and Flatness; Measurement of screw thread; Surface Measurements; Coordinate Measuring Machines Statistical process control; economics of quality control; acceptance sampling plans and selection.

Classification of various tests on the basis of type &rate of loading. Principles of different tests viz tensile, compression, bend ,torsion, impact, hardness, toughness etc. Variables affecting these tests.

Principles, classification; testing techniques, merits, demerits &field of application; of various non- destructive tests and inspections viz, Visual inspection, Radiography, Ultrasonic, Magnetic Particle, Eddy current, Dye penetrate, Holography, Optical microscopy, Fractography Statistical parameters for quality assurance, Prediction of processes or product quality using normal distribution, Sampling inspection, Use of control charts. Applications of these tests in Foundry & Forge Industries. Case studies.

Forging of Non-ferrous and Special Alloys (3 – 0 – 2)

Aluminum and aluminum alloys used for forging industries. Their forging characteristics. Methods of forging of these alloys. Hammer & press forging of these alloys. Technology of die forging, design of dies forging aluminum forging. Upset forging, ring forging, free forging of aluminum alloys, Defects in forging.

Copper and copper alloys used for forging. Their forging characteristics & methods of forging.

Other non-ferrous alloys, viz. Ti & Mg alloys used for forging; their forging characteristics & methods of forging.

Classification of steels, Ingot solidification -solidification, characteristics, electroslag melting processed advanced technology for producing large forging ingot by central zone remelting; Overheating & burning of steel. Guide-lines for avoidance of overheating; Heat treatment for removal of overheating ;Anti-flaking treatment.

Stainless steel &their classifications, Forging of stainless steel. Effect of cooling during forging on the microstructure and mechanical properties of stainless steel forging. Die forging of stainless steel with specific examples.

Cast high speed steel. Purpose of forging high speed steel. Forging technique, metallographic control during forging. Effect of forging on subsequent heat treatment process of high speed steel.

Heat Treatment Technology (2 – 0 – 2)

Alloying behavior of iron and decomposition of Austenite, Diffirsionless and Diffusion controlled transformations; pearlitic, bainitic and martensitic transformations, concept of hardness and hardenability, mass effect etc. Surface and volume hardening, tempering, annealing, normalizing; Heat treatment of alloy steel castings and forgings, stainless steels, Hadfield steels, spring steels, Heat treatment of cast iron, malleable iron and S.G. iron, Heat treatment of Non-ferrous metals and alloys, theory of age hardening; Heat treatment of Brasses, Bronzes, Aluminium, Titanium & Magnesium alloys forging.

Industrial Engineering & Management (2 – 1 – 0)

Introduction; major areas of application; production planning and control; types of production; prior planning, forecasting, loading, scheduling and sequencing; Inventory control, types of - production, Material requirement planning.
PERT & CPM network and its uses. Operations research and its applications, Graphical method and Simplex methods of solving linear programming problems
Work-study: Method study and work measurement; work sampling; applications, Project planning, costing and estimating for castings and forgings; Forms of Industrial enterprises; Human resource development; productivity of foundry & forge industries.

Friction & Lubrication in Forging (3 – 0 – 2)

Plastic flow and interface friction, lubrication and wear in metal deformation. Hot I Warm / Cold forging lubricants .Lubricants for ferrous and non-ferrous alloys forgings' Evaluation of forging lubricants. Evaluation of Die wear, Estimation of die life'

Rolling, Extrusion & other sheet Metal working (3 – 0 – 2)

Classification of various metal working processes, Cold &hot working of metals, Heating for working, Cooling after working, General concepts of rolling, Theory of rolling, Fundamentals of roll pass design, Theories of other metal working processes, viz, Extrusion, Drawing, Non- Conventional methods of working.

Welding (3 – 0 – 2)

Introduction, Physics of Welding Arc, Welding Power Sources, Arc Welding Processes, Heat flow in welding, Design of weld joints, Testing and inspection of weld joints, Weldability of metals, Weld overlay. Repair of forging dies.