

M.Tech (FOUNDRY- FORGE TECHNOLOGY)

Name of the M. Tech. Programme	Foundry - Forge Tech.
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Distribution of Credits

Programme Core	Programme Elective	Total Credits
72	08	80

Course No.	Year	Semester	Course Title	L-T-P	Credits
1.1.	I	I	Phy.Metallurgy of Casting & Forging	3-0-2	4
1.2.			Advanced Engg. Mathematics	3-1-0	4
1.3.			Foundry Tooling & Methoding	3-0-2	4
1.4.			Tech. of Mould & Core Making	3-0-2	4
1.5.			Tech. of Ferrous Forging	3-0-2	4
1.6.			Heat Treatment Technology	3-0-2	4
Total Credits					24

Course No.	Year	Semester	Course Title	L-T-P	Credits
2.1.	I	II	Tech. of Ferrous Casting	3-0-2	4
2.2.			Tech. of Non-Ferrous Casting	3-0-2	4
2.3			Forging Die-Design & Manufacturing	3-0-2	4
2.4.			Tech. of Non- Ferrous Forging	3-0-2	4
2.5.			Quality Assurance and Insp. Method	3-0-2	4
2.6.			Elective –I		4
Total Credits					24

Course No.	Year	Semester	Course Title	L-T-P	Credits
3.1.	II	I	Near Net Shape Process	3-1-0	4
3.2.			Elective II		4
3.3			Seminar		2
3.4.			Industrial Training		2
3.5.			Project Part –I (Presentation)		3
Total Credits					15

Course No.	Year	Semester	Course Title	L-T-P	Credits
4.1.	II	II	Project Part II		15
4.2.			Comprehensive Viva Voice		2
Total Credits					17

Total Credits = 80

2.6 Elective –I

- 2.6 (a) Energy Conservation & Pollution Control
- 2.6 (b) Finite Element method and Applications
- 2.6 (c) Modern Casting Process
- 2.6 (d) Industrial Engg. & Operation research.
- 2.6 (e) Rapid Prototyping

3.2 Elective –II

- 3.2 (a) Modeling & Simulation
- 3.2 (b) Recent Trends in Forging Tech.
- 3.2 (c) Non Traditional Machining
- 3.2 (d) Computer Aided Design
- 3.2 (e) CNC & Programming

Note: Students feedback is invariably obtained in all semesters in all subjects

ME:	Manufacturing Engineering
MME:	Materials & Metallurgical Engineering
Fdy:	Foundry Technology
Forge:	Forge Technology

M. TECH. FOUNDRY FORGE TECHNOLOGY COURSE SYLLABI

IST SEMESTER

1.1. Physical Metallurgy of Casting & Forging. (3 0 2)

Solid solutions- theories of alloying, Intermediate phases and intermetallic compounds. Common binary equilibrium diagrams and their interpretation, Introduction to ternary equilibrium diagram. Diffusional & diffusionless transformation, Concepts of structure property processing co- relation Strengthening of metals & alloys and its mechanism.

Solidification of metals & alloys, Casting grain structure; Ingot structure dendritic and cellular dendritic growth, multiphase microstructures. Micro & Macro segregation, Micro & Macro porosity and residual stresses in casting.

Hot and cold working of metals & alloys, recovery, recrystallisation and grain growth. Evolution of microstructure in hot & cold forged alloy.

1.2 Advanced Engg. Mathematics (3 1 0)

Vector calculus; Gauss, Stoke's and Green's Theorems; Tensor analysis; Computational Fluid Dynamics; Discontinuous Flow; Vortices and Viscosity; Boundary Layer Theory

Matrices and Determinants Equations; Cayley- Hamilton's Theorem; Inversion of large matrices Ordinary Differential Equations; Exact Defferential Equations; Total Differential Equations; Partial Differential Equatins; Mongee's Method, Separation of Variables. Special functions: Bessel, Legendre, Hypergeometric Hermite, Lagurve and Green's Funcions Fourier Series; Fourier Transforms, Laplace Transforms; Hankel Transform; Application in solution to Laplace, wave and heat conduction equations.

Complex variables; Conformal mapping; Contour Integrals. Numerical Methods; Interpolation, Differentiation, Solution of ordinary differential equations and Algebraic and Transudental equations. Finite element technique; Weighted residual and variational methods.

1.3 Foundry Tooling and Methoding (3 0 2)

Pattern Equipment for quality production of castings : Pattern plates: types, materials used; design and constructional features suiting to various moulding machines. Special design features for high pressure moulding machines.

Core Boxes: type , materials used, design and constructional features for core blowing and shooting machines. Special features for shell core shooters .Core print. Gravity Die casting: Die-Types, and design features. Pressure Die-casting: die- design features.

Gating : Elements of the gating system. Design of Gating system for cast iron & steel.

Fluidity and its significance in casting.

Risering : Solidification of iron and steel with reference to Fe-C diagram. Riser classification. Design of riser. Methods to achieve directional solidification.

1.4 Technology of mould and core Making (3 0 2)

Sand :occurrence, classification and characteristics of different types of sand, grain size, shape and distributions.

Binders :Clay, Linseed oil, dextrin, sodium silicate, molasses, their characteristics and quality tests.

Green and dry sand practices, carbon dioxide and shell process. Role and function of additives & washes in conventional mould & core making processes.

Moulding practices, Odd side, three part, loam, sweep & pit moulding, skeleton patterns, stack moulding, core assembly.Core making practices :- small and large cores, swept cores ,loam cores, skeleton cores.Mould and core venting, reinforcement & drying. Machines for sand mixing and preparation of moulds & cores like mixer, muller, jolting, Squeezing, jolt-squeezing, slinging, blowing and shooting machines. Their functions & characteristics, Core location, closing and weighting of moulds. Sand reclamation methods & equipments.Casting defects mainly attributed to moulding and core making practices and materials.

1.5 Technology of Ferrous Forging (3 0 2)

Technology of open- die forging; Allowance and tolerances for free forging; Process chart for manufacture of typical components such as straight, stepped and hollow shaft, rings, discs, crank shaft, etc; Forging defects and their remedial measures
Classification, and characterization of forging equipments; Load and energy characteristics; Classification viz, pneumatic hammer, drop hammer, counter blow hammer, mechanical and hydraulic presses, upsetters, HERF machines, etc; Foundation of hammer; Recent development in forging equipment Methods of blank preparation; Acceptance criteria for bars & billets in forging industry, Advanced technology for production of large forging ingots, Factors affecting metal flow in the die, such as forgeability, friction, lubrication, die temperature, shape and size factors; Forging of steel, Forging of Stainless Steel, Forging of high Speed Steel, Problems of gases, overheating and burning of steels.

1.6 Heat Treatment Technology (3 0 2)

Decomposition of austenite, Diffusion controlled and diffusionless transformations; Nucleation and growth of phases; Pearlitic and bainitic transformations; Mechanism of martensitic transformations; Determination of grain size; TTT and CCT curves
Heat treatment processes; Hardening, Tempering, Annealing, Normalizing, Surface Hardening, Carburizing, Nitriding, Electron Beam Hardening and Laser Hardening; Application of Plasma in heat treating. High Temperature Carburising. Heat Treatment of tool and alloy Steels; Heat treatment of cast iron ; Heat Treatment of tool and alloys Steels; Heat treatment of weldments; Thermomechanical treatment; Heat treatment of non-ferrous metals and alloys; Theory of age-hardening; Heat Treatment defects in castings, forgings and weldments and their remedial measures. Automation & computerization of heat treating process & equipments. Controlling heat treating furnace atmosphere.

IInd Semester

2.1 Technology of Ferrous castings (3 0 2)

Fe-C phase diagrams; classification, properties and applications of cast irons and steel. Solidification behavior and effect of alloy additions.
Melting furnaces used for iron and steel: electric arc furnace, induction furnace, cupola, rotary furnace. Melting practices and melt controls for iron and steel. De-oxidation and degassing of steel;
Inoculation and alloying of cast irons. Production of grey, S.G., C.G. and malleable irons. Moulding and core making practice for iron and steel. Gating and feeding practices for iron and steel. Fettling, cleaning and heat treatments of castings; Defect analysis.

2.2 Technology of Non-Ferrous castings (3 0 2)

Non-ferrous alloys based on Al, Cu, Zn and Mg. Their properties and applications. Solidification and microstructure of important non ferrous alloys. Melting, fluxing, degassing and pouring practices . Filtration of non- ferrous melts. Melt treatment : modification and grain refinement. Charge calculation, hardeners. Oxidation and gas absorption in metals and alloys, detection of gases. Mould and core practices, metal-mould reaction, gating and feeding practices. Defect analysis, salvaging of castings.

2.3 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 temperature while forging. Calculation of weight of falling parts or die of a drop hammer, Mechanical press, Selection of the size of massive die blocks or insert dies. Production of die blocks and factors controlling their quality. 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, bender , blocker, finishing impression, dovetail , cross, key and tapered key. Laws governing the design of the dies of horizontal forging machine. Design of punches and heading tools for upsetter (horizontal forging machine).upsetting rule, coning Tool Design Method.

Determination of capacity of trimming press. Design of trimming and piercing tool, die clearance between punch and die. Design of stripping and clipping tools. Assembly detail for trimming. Technical requirements for sinking, re-sinking and rectification of dies, Die sinking methods like copy-milling, EDM, ECM etc. Instruction for mounting, setting and working of dies, Reduced Roll design, saved perform design. Die life improvement Computer aided design of forging dies, Optimization of die design parameters, Optimum material utilization, Modeling and analysis of forging process using software.

2.4 Technology of Non-Ferrous Forging (3 0 2)

Classification & properties of commercial aluminum alloys & their metallurgical characteristics, Forging behavior of aluminum alloys; Heat treatment technology and industrial application of the alloys
Designation, properties and application of copper and magnesium alloys forgings;
Forging practices of copper, copper alloys and magnesium alloys
Heat treating practices and their applications, forging practices for titanium alloys, current forging technology for aerospace materials. Forging of Aluminum. Lithium alloys. Tribological behavior during forging.

2.5 Quality Assurance and Inspection Methods (3 0 2)

Statistical parameters for quality assurance; Probability desirability distribution curves for discrete and continuous random variables; Control charts for attributes and variables; Special control charts; Process capability; Acceptance sampling; On-line

Inspection; Quality circle, Quality cost, Quality audit; Total quality management; Use of computers in quality assurance.

Destructive and non-destructive methods of inspection as used for casting, forgings and weldments; Optical microscopy; photomicrography; Fracture tests; Analysis of casting and forging Defects.

3.1 Near Net Shape Processes (3 0 2)

Concept of Shape, size, accuracy, tolerances and surface roughness. Economical and technological factors; improved material and energy efficiency, dimensional accuracy, product integrity and reduced manufacturing cost through near net processing . Foundry processes ; Shell process, investment casting, ceramic moulding , plaster mould process, V-process, squeeze casting, rheo-casting, permanent mould casting, low pressure die casting and pressure die casting processes.

Plastic deformation processes; warm forging, flashless forging, cold forging. Super plastic forming, powder metal forging, liquid forging, rheo-forging and isothermal forging processes.

Electro forming; principles of electro deposition, production of dies and moulds by electro-forming.

Elective I

2.6 (a) Energy Conservation & Pollution Control

Energy Conservation: Conventional and Non-Conventional Energy Sources; Conservation of energy; Utilization of waste heat etc. in Foundry, Forge and Allied Industries; Energy Conservation and Management in Refractory units.

Pollution Control:

Air quality, Air pollution- sources and nature of air pollutants, Air pollution control equipment for particulate contaminants and gaseous contaminants. Air pollution monitoring.

Water Pollution- Water quality, Waste water treatment, Environmental waste Management.

Noise Pollution- Generation, Assessment and Control in Foundry, Forge and other Industries, preventive and control measures.

2.6 (b) Finite Element method and Applications

Introduction to FEM modelling

Heat Transfer: Coordinates and Shape Functions – Linear, Quadratic, Triangular, Axisymmetric, Euler – Langrange Equation, Galerkins Approach, Assembly of the Global Stiffness Matrix, Boundary Conditions such as Convection, Radiation etc., Unsteady State Heat Transfer Problems using Finite Difference Time Stepping Techniques like Euler, Crank – Nicolson’s and Implicit Methods, Point Sources, Torsion of Shots.

Solid Mechanics: The Potential Energy Approach, Galerkin Approach, The Finite Element Equations for One Dimensional Problems and Treatment of Foundry Conditions,

Temperature Effects, Plane Trusses, Two Dimensional Problems using Constant Strain Triangles, Beams.

Introduction to Mass Transfer, Fluid Flow and Plate Bending

Local Coordinate System: Shape Functions in Local Coordinate System and Evaluation of Element Characteristic Matrices and Element Characteristic Vectors.

2.6 (c) Modern Casting processes

Process details, in gradients used, process variables and economy of the processes using sodium silicate as binder and organic binder processes e.g hot box, cold box, ABC, silicate- ester, catalyzed no-bake and warm box.

Fluid sand, full mould, magnetic moulding, investment casting, frozen mould, vacuum sealed moulding, high pressure moulding, impact moulding; explosion moulding and squeeze casting processes. Centrifugal casting and continuous casting processes.

2.6 (d) Industrial Engg. & Operation research.

Introduction to Production, planning and control, Inventory Control, MRP, Design of experiments, Taguchi Methods and Multivariate analysis, Network models, CPM and PERT. Times cost trade off and generation of the project cost curve in determining the networks. Fulkerson's flow algorithm, Non-linear programming, Integer and Dynamic programming, waiting line theory and its applications

2.6 (e) Rapid Prototyping

Basic Principal of RP processes, Classification of RP Processes, Various Industrial RP Systems like Sterolithography, Fused Deposition Modeling, Selective Laser Sintering, Laminated Object Manufacturing, 3D Printing, Ballistic particle modeling etc., Role of Rapid Prototyping and Rapid Tooling in Product Development. Process planning for rapid prototyping, STL file generation Defects in STL files and repairing algorithms, Slicing and various slicing procedures, Accuracy issues in Rapid Prototyping, Strength of RP Parts, Surface roughness problem in Rapid Prototyping, Part deposition orientation and issues like accuracy, surface finish, build time, support structure, cost etc., Rapid tooling techniques such as laminated metallic tooling, direct metal laser sintering. Introduction to reverse engineering Integration of reverse engineering and rapid prototyping.

3.2 Elective II

3.2 (a) Modelling & Simulation

3-D modelling of molds & forging dies using solid modeller; Simulation and analysis of close die forging of forged components, such as gear blank connecting rod, crank shaft, rocker arm using FEM based software packages. Simulation of metal flow in moulds,

solidification pattern analysis, microstructure and stress distribution in castings using industry standard FEM based software packages.

3.2 (b) Recent Trends in Forging Technology

Forging processes involving the use of electrical upsetters, orbital forging presses; Automatic horizontal forging presses and multiram forging presses. 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.

3.2 (c) Non Traditional Machining

Newer Processes in Manufacturing - Process Principles, Process Parameters, Advantages & Limitations and Industrial Applications of Processes such as Abrasive Jet Machining (AJM), Water Jet Machining (WJM), Abrasive Water Jet Machining (AWJM), Abrasive Flow Machining (AFM), Ultrasonic Machining (UM), Electro Chemical Machining (ECM), Electro Chemical Grinding (ECG), Electro Chemical Discharge Grinding (ECDG), Shaped-Tube Electrolytic Machining (STEM), Electro Stream Drilling (ESD), Chemical Machining (CM), Electrical Discharge Machining (EDM), Electrical Discharge Wire Cutting (EDWC), Electron Beam Machining (EBM), Laser Machining (LM), Plasma Arc Cutting (PAC), Thermal Energy Method Deburring (TEM), Ion Beam Machining (IBM), Introduction to Micro-Machining.

3.2 (d) Computer Aided Design

Principles of computer aided design. Computer graphics fundamentals. Points and lines. Transformations and projections. Plane curves. Space curves. Surface description and generation. Surface modelling. Solid modelling, Representation of 3-D objects.

Modelling using Solid Modeler. Part Modelling, Creating Geometry , Operations , Modifying parts, Parametric design, Surface Modelling .

3.2 (e) CNC & Programming

Introduction to NC/CNC/DNC, Basics elements of CNC, Introduction to Part Programming, Radius and Length Compensation Schemes, Tooling & Work-holding for CNC machine tools, Advanced Programming Features & Canned Cycles, Geometric Modeling for NC machining & Machining of Free-form Surfaces, NC program generation from CAD models, Introduction to APT programming, Post processor, NC Program verification and Virtual NC, Recent developments in CNC machine tools