Chhattisgarh Swami Vivekanand Technical University, Bhilai

Scheme of Teaching and Exam

B.E. VII Semester Metallurgical Engineering

S. No	Board of Study	Subject Code	Subject	Periods per Week			Scheme of Exam			Total Marks	Credit L+ (T+P)/2
							Theory/practical				
				L	T	P	ESE	CT	TA		
1	Metallurgical Engineering	338731(38)	Foundry Technology	4	1	-	80	20	20	120	5
2	Metallurgical Engineering	338732(38)	Deformation behavior of Materials	4	1	-	80	20	20	120	5
3	Metallurgical Engineering	338733(38)	Corrosion and Degradation of Materials	4	1	-	80	20	20	120	5
4	Metallurgical Engineering	338734(38)	Alloys Their Properties and Selection	4	1	-	80	20	20	120	5
5	Refer Table – II		Professional Elective – II	4	1	-	80	20	20	120	5
6	Metallurgical Engineering	338761(38)	Foundry Technology Lab	-	-	2	40	-	20	60	1
7	Metallurgical Engineering	338762(38)	Alloys and Their Properties and Selection Lab	-	-	3	40	-	20	60	2
8	Metallurgical Engineering	338763(38)	Corrosion and Degradation of Materials Lab	-	-	3	40	-	20	60	2
9	Metallurgical Engineering	338764(38)	Minor Project	-	-	4	100	-	40	140	2
10	Management	338765(76)	Innovative and Entrepreneurial Skills	-	-	2	-	-	40	40	1
11	Metallurgical Engineering	338766(38)	**Practical Training Evaluation and Library	-	-	1	-	-	40	40	1
Total				**20**	**5**	**15**	**620**	**100**	**280**	**1000**	**34**

L - Lecture T - Tutorial P - Practical, ESE = End Semester Exam CT Class Test TA - Teacher's Assessment

**to be completed after VI sem and before the commencement of VII sem

Table - II

S.No.	Board of Study	Subject Code	Subject
1	Metallurgical Engineering	338741 (38)	Alternative Routs of Iron and Steel Making
2	Metallurgical Engineering	338742 (38)	Design and application for Engineering Materials
3	Metallurgical Engineering	338743(38)	Ferro Alloy Technology

Note: (1) - 1/4th of total strength of students subject to minimum of twenty students is required to offer in elective in the

Note: (2) - Choice of elective code once made for an examination can not be changed in future examinations.

CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI (C.G)

Semester: VII **Branch: Metallurgical Engg.**
Subject: Foundry Technology **Code: 338731(38)**
Total Theory Periods: 40 **Total Tut Periods: 12**
Total Marks in End Semester Exam: 80
Minimum number of class test to be conducted: 2

COURSE OBJECTIVES

- To learn the basic principles of solidification of metals and foundry technology.
- To utilize the knowledge for industrial application
- Apply basic scientific principles for technical problem solving in foundry to increase Technical Skills

Unit – I

Solidification of pure metals and alloys, parameters affecting the solidification. Concept of directional and controlled directional solidification and methods to attain directional solidifications, Interdendritic shrinkage, center line shrinkage phenomenon in castings, Macro and Micro segregation, gases in castings

Unit – II

Fluid flow principles for melts and Gating system and its design, Design of ingate, sprue, runner, requirements of an ideal gating system, types of gates. Feeders requirements and functions of feeders. Feeder design, Risers. Risering methods, Caine's method, NRL method, Wlodawer's process, methods of riser design for various shapes of castings. Construction and design of pattern, pattern allowances, pattern colours. Evaluation of Chvorinov's equation and its importance in other calculation.

Unit – III

Patterns**;** Moulding Sands; General Characteristic, ingredients and their effects on properties of moulding sands Testing of moulding sands. Banking and facing sands, sand conditioning. Cores- Function, types, core sands, core binders, core preparation, core was, core supports.

Unit – IV

Moulding and Casting Processes; Various process of molding and casting like green and dry sand core sand, shell moulding, CO_2 process, permanent molds. Centrifugal investment, die casting. Moulding equipment, process details and applications.

Unit – V

Melting Practice**;** Principle of melting, construction and operation of hot and cold blast cupola. Recent trends in cupola. Melting of steel and alloy steels in Arc and induction furnace. Melting, and casting practice of aluminum, copper and their alloys. S.G. Iron foundry Finishing, inspection and quality control, defects in castings and their remedies. Heat treatment of castings.

Text Book and references:

1. Foundry Technology - P.R. Beeley
2. Principles of metal casting, R.W. Heine, C.R. Loper and P.C. Rosenthal
3. Solidification of casings – Institute of Metals, London – R.W. Ruddle
4. Metal casing. – R.A. Flin

METHODOLOGY

- Lecture, PPT- Presentation, Class Discussions
- Students' self study
- Tutorial Classes
- Interactions with the respective Faculty
- Industry Visit

EXPECTED OUTCOME

Foundry is one of the most important metal processing techniques. This will help in designing the process as well as solving the practical problems encountered while metal processing

CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI (C.G)

Semester: VII **Branch: Metallurgical Engg.**
Subject: Deformation behavior of Materials **Code: 338732(38)**
Total Theory Periods: 40 **Total Tutorial Periods: 12**
Total Marks in End Semester Exam: 80
Minimum number of class test to be conducted: 2

COURSE OBJECTIVES

Deformation behavior of materials is an important criterion for metal fabrication as well to understand the failure of materials during service.

Unit – I

Concept of stress and strain. Elastic and plastic behavior of metals. Stress-strain relationship. Theory of elasticity. Deformation under tension, shear and torsion., Theory of plasticity. Flow curve, true strain. Deformation theories.

Unit – II

Plastic deformation of single crystals; Deformation by slip, slip by dislocation movement, critically resolved shear stress for slip, deformation by twining. . Plastic deformation in polycrystalline material; grain boundaries and deformation, yield point phenomenon and strain aging. Strain hardening and cold work, Bauschineger effect.

Unit – III

Theory of dislocation; Burges vector and dislocation loop, dislocation in FCC, BCC and HCP lattice. Stress field of a dislocation, forces on and between dislocations. Dislocation climb, jogs in dislocation, vacancy and foreign particle interaction. Dislocation sources, Multiplication of dislocation- Frank –Read sources. Dislocation pile-up.

Unit – IV

Mechanics of metal forming; role of friction effect of temperature, metallurgical structure and speed on deformation on forming processes.. Experimental techniques on forming operations. Forces and geometrical relationships in rolling, forging, extrusion and deep drawing. Mathematical modeling.

Unit – V

Fracture; type of fractures. Theoretical cohesive strength of metals, Griffith theory of brittle fracture. Metallurgical aspects of ductile and brittle fracture. Dislocation theory of fracture, velocity of crack propagation. Fatigue and creep failures.

METHODOLOGY

- Lecture, PPT- Presentation, Class Discussions
- Students' self study
- Tutorial Classes
- Interactions with the respective Faculty
- Industry Visit

EXPECTED OUTCOME

The knowledge will help in the design, metal processing, fabrication and failure analysis.

CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI (C.G)

Semester: VII **Branch: Metallurgical Engg.**
Subject: Corrosion and Degradation of Materials **Code: 338733(38)**
Total Theory Periods: 50 **Total Tutorial Periods: 12**
Total Marks in End Semester Exam: 80
Minimum number of class test to be conducted: 2

Objective: To understand the principles of electrochemistry, corrosion and metal degradation

Unit – I

Electro-chemical nature of corrosion. Principles of Electrochemistry; Aqueous electrolytes, ionic conductivity; pH Electrolytic conduction Electrode Potential, Equilibrium decomposition and Redox potentials, cell mechanism and thermodynamics E.M.F.series polarization and over voltage current efficiency and energy efficiency of electrolytic processes calculations based on the above.

Unit – II

Types of corrosion. Mechanism of high temperature oxidation, galvanic corrosion, crevice corrosion, pitting corrosion. intergranular corrosion, hydrogen cracking, dezincification.

Unit – III

Mechanically induced corrosion**;** stress corrosion cracking, corrosion fatigue, cavitation corrosion, fretting corrosion. Erosion corrosion,

Unit – IV

Corrosion prevention**;** Basic principles, effect of design, selection of materials, cathodic and anodic protection metallic and inorganic surface coating, inhibitors.Corrosion rate measurement.

Unit – V

Root cause analysis of corrosion failures. Corrosion problems in chemical, petrochemical, fertilizer, power plants, steel industries and their solutions.

Name of Text Books :

Corrosion Engineering – Fontana and Greene

Name of Ref. Books

- Introduction to Electrochemistry – S. Glasstone
- Chemical Metallurgy – J. J. Moore
- Corrosion causes and Prevention – Speller

METHODOLOGY

- Lecture, PPT- Presentation, Class Discussions
- Students' self study
- Tutorial Classes

EXPECTED OUTCOME

To design and selection and protection of materials under aggressive environment.

CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI (C.G)

Semester: VII **Branch: Metallurgical Engg.**
Subject: Alloys their properties and Selection **Code: 338734(38)**
Total Theory Periods: 40 **Total Tut Periods: 12**
Total Marks in End Semester Exam: 80
Minimum number of class test to be conducted: 2

Objective: To learn the effect of different alloying element on the steel and understand the concept for production of different alloy steel for appropriate use.

Unit – I

Function of Alloying elements in steel: Limitations of plain carbon steel, General effect of alloying elements, mode of combination of alloying elements, Effect of alloy elements on transformation temperature, effect of alloying elements on critical cooling rate, on hardenability and on tempering. Low alloy steels:- Low alloy steels such as high tensile structural steel, case carburizing steels, nitriding steels, ball bearing steels, spring steels, low alloy high strength structural steels.

Unit – II

Study of high Ni steels, high speed steel, die steel, Hadfield steel and managing steel.

Unit – III

Cast Irons: Structure and properties of white cast irons, gray cast iron, malleable cast iron, nodular cast iron and alloy cast irons. Study of Stainless steels, heat resistant high strength steels and ausformed steels.

Unit –IV

Non ferrous alloys: Structure and properties of Brasses, bronzes, babbits. Structure and properties of titanium alloys, Aluminium alloys, Monels, brazing and soldering alloys.

Unit –V

Metals at low temperatures: Effect of low temperature on properties, Effect of low temperature on notched bar test, Metallurgical factors, and mechanical factors. Magnetic steels and alloys. Alloys for electrical applications. Zirconium alloys in nuclear technology. Amorphous metals. Specifications of alloys:- ISI, AISI and En standards (Basic conceptsonly).

Text Books

- Physical metallurgy for engineers- by D.S. Clark and Warne.
- Structures and Properties of alloys- by Robert M. Brick and Phillips.
- Introduction to Physical metallurgy- by Sidney H. Avner.

METHODOLOGY

- Lecture, PPT- Presentation, Class Discussions
- Students' self study
- Tutorial Classes
- Interactions with the respective Faculty
- Industry Visit

EXPECTED OUTCOME

The knowledge of this syllabus will help in the production of alloys steel , cast iron and nonferrous alloys as per the need.

CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY,
BHILAI (C.G)

Semester: VII **Branch: Metallurgical Engg.**
Subject: Alternative Routes of Iron and Steel Making **Code: 338741(38)**
Total theory Periods: 40 **Total Tutorial Periods: 12**
Total marks in end semester examination: 80

COURSE OBJECTIVE:

To learn the alternative routes of iron and steel making. To be able to design or optimize the emerging processes.

Unit - I

Review of the BF process and its deficiencies of BF. Technical issues limiting the process capabilities; raw material, maintenance, life span and obsolescence, environmental, downstream capabilities, economics. The green steel making technologies. Introduction and categorization of alternative technologies.

Unit – II

Sponge iron processes for production of solid iron/DRI. Coal based processes; Rotary Kiln, Krupp-Renn process, Krupp-CODIR process, SL/RN(Outcompu) process, ACCAR process, DRC process,

Unit – III

Gas based Sponge Iron processes: MIDREX, HYL, Indigenous processes: JINDAL and TDR technology. Fastmet process

Unit – IV

Liquid Iron Making Smelting Reduction processes: COREX, ROMELT, ITmk3 (Nuggets), Hismelt,

Unit - V

New steel making technology: modification of BOF; bottom blowing, combined blowing, Energy Optimization Furnace (EOF), Horizontal continuous casting, Thin slab casting, near net casting, concept of mini integrated steel mills. Steel industries - tomorrow and far future. Indian scenario.

METHODOLOGY

- Lecture, PPT- Presentation, Class Discussions
- Students' self study
- Tutorial Classes
- Interactions with the respective Faculty
- Industry Visit

EXPECTED OUTCOME

The student will aware of use of appropriate furnace for the production of iron and steel by alternative routes. They will also benefited by applying the above knowledge to modify the furnace for production of same at low cost.

CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI (C.G)

Semester: VII **Branch: Metallurgical Engg.**
Subject: Design and Application of Engineering Materials **Code: 338742(38)**
Total Theory Periods: 50 **Total Tut Periods: 12**
Total Marks in End Semester Exam: 80
Minimum number of class test to be conducted: 2

Objective: To learn the concept of design the engineering materials and know the application of designed engineering materials.

Unit-I

Materials and Design,Evolution of Engineering Materials,Material Resource in Indian scenario.C lassification of Materials,Overview of Materials and properties, metallic alloys, ceramics & glasses polymeric & composite materials

Unit -II

Factors in Material Selection.Material Selection using Ashby Method,Multiple Constraints in m aterial selection,Multiple Objectives,The Role of shapes, Selection of Shapes. Co-selection of Materials and Shapes

Unit -III

Review of Manufacturing Processes. Design for Casting, Bulk Deformation Processes, Machining, Polymer Processing, Powder Metallurgy. Co-selection of Materials and Processes.

Unit -IV

Review of Assembly Processes. Design for Welding, Brazing and Soldering, Adhesive Bonding. Joining of Polymers, Design for Heat Treatment

Unit -V

Design for Reliability. Case Studies; materials selection for Vehicle Body , aircraft wings, cutting tools, gas turbine blades, artificial hip replacement, automobile value spring etc.

Texts/References:

N A Waterman and M F Ashby, The Materials Selector, Vols. I, II and III, Chapman and Hall, London, 1996.

METHODOLOGY

- Lecture, PPT- Presentation, Class Discussions
- Students' self study
- Tutorial Classes
- Interactions with the respective Faculty
- Industry Visit

EXPECTED OUTCOME

The concept will help in the selection and designing the engineering material as per the requirement.

CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI (C.G)

Semester: VII **Branch: Metallurgical Engg.**
Subject: Alloys their properties and Selection Lab **Code: 338762(38)**
Total Practical Periods: 28 **Total Tut Periods: NIL**
Total Marks in End Semester Exam: 40
Minimum number of class test to be conducted: 2

COURSE OBJECTIVE:

To learn processes of production and characterization of low melting alloys**.**

Experiment to be performed

1. Casting of Al alloy
2. Study of the microstructure of Al alloys
3. Determination of the mechanical properties of Al alloys.
4. Study of the microstructure of cast iron
5. Determination of mechanical properties of cast iron
6. Study of the microstructure of steel
7. Determination of mechanical properties of steel
8. Study of the microstructure of Cu based alloys
9. Determination of the mechanical properties of Cu based alloys
10. Study of the microstructure and determination of mechanical properties of HSLA Steel

List of Equipments/Machine Required:

1. Crucible
2. Heat Treatment furnace
3. Master alloys
4. Metallurgical Microscope
5. Polishing and etching materials/equipments.

Recommended Books:

1. Lab manuals
2. Structures and properties of alloys – by Robert M Brick and Phillips

METHODOLOGY

- Practical operation
- Students' self study
- Industry Visit

EXPECTED OUTCOME

The student will be able to utilize the concept to produce at least low melting alloys and their characterization like metallographic inspection.

CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY,
BHILAI (C.G)

Semester: VII **Branch: Metallurgical Engg.**
Subject: Corrosion and Degradation of Materials Lab **Code: 338763(38)**
Total Practical Periods: 40 **Total Tut Periods: NIL**
Total Marks in End Semester Exam: 40
Minimum number of class test to be conducted: 2

Course Objective:

To learn the concept regarding the degradation of materials. To understand the behavior of corrosive environment on the respective materials. The student should learn the handling of equipment used for determination of rate of corrosion.

Experiment to be performed

1. Corrosion rate measurement by weight loss study
2. Corrosion rate measurement by electro-chemical study
3. Study of galvanic corrosion by different combination of metals
4. Study of stress corrosion of brass and steel.
5. Corrosion in sulfide environment.
6. Effect of Inhibitors on corrosion behavior of steel
7. Oxidation loss at high temperature
8. Study of corrosion in different industries

List of Equipments/Machine Required:

1. Potentiostate
2. Required chemicals, $CuSO_4$, H_2SO_4, etc
3. PH measuring instrument
4. Required metals, copper, zinc, steel brass etc.
5. Digital weight balance.
6. High temperature furnaces
7. Optical Microscopes

METHODOLOGY

The student will learn the concept regarding this syllabus by doing experiment in laboratory and industrial visit.

EXPECTED OUTCOME

The student should aware of the effect of corrosive environment and must have mastery in handling the equipment relation corrosion parameter measurement.

CHHATTISGARH SWAMI VIVEKANAND TECHNICAL UNIVERSITY, BHILAI (C.G)

Semester: VII **Branch: Metallurgical Engg.**
Subject: Foundry Technology Lab **Code: 338761(38)**
Total Practical Periods: 40 **Total Tut Periods: Nil**
Total Marks in End Semester Exam: 40

Course objective:

To learn the concept of different casting techniques and know the requirement of different foundry appropriate equipment and accessories.

Experiment to be performed:

1. Melting of medium carbon steel in an induction furnace and pouring in a mold
2. Melting in crucible furnace and pouring of Cu castings
3. Melting in a pot furnace and pouring Al/Al alloys castings
4. Calculation of Metal flow rate and velocity using Bernoulli's Theorem.
5. To design a runner and gates of a mold.
6. To design a feeder head (or Riser system) considering freezing time, freezing range and volume feed capacity
7. Calculation of heat loss from open riser
8. Study of coring (or segregation) during fast cooling of casting.
9. To design for a sand casting considering various important factors
10. Study of defects in castings, their causes and remedy.

List of equipments:

1. Crucible furnace
2. Induction furnace
3. Pot furnace (fuel fired)
4. Met microscope
5. Mechanical testing equipment
6. Non-destructive testing equipment.

METHODOLOGY

The student will learn the concept regarding this syllabus by doing experiment in laboratory and industrial visit.

EXPECTED OUTCOME

By doing the experiment students should have the knowledge of different foundry equipments, their use and different type casting processes.