Name of Institute: IITE
Name of Faculty: Mr. Monil Salot

Course code: MME0504
Course name: Foundry Technology
Pre-requisites: Material Science, Fuel Furnace and Refractories
Credit points: 04
Offered Semester: 05

Course Coordinator
Full Name: Mr. Monil Salot
Department with siting location: Metallurgical Engineering, Bhanwar Building, Lab-004 (GF)
Telephone: 9428600336
Email: monilsalot.mt@indusuni.ac.in
Consultation times: 3:45-4:20 PM

Course Lecturer
Full Name: Mr. Monil Salot
Department with siting location: Metallurgical Engineering, Bhanwar Building, Lab-004 (GF)
Telephone: 9428600336
Email: monilsalot.mt@indusuni.ac.in
Consultation times: 3:45-4:20 PM

Students will be contacted throughout the Session via Mail and Google Classroom with important information relating to this Course.

Course Objectives
By participating in and understanding all facets of this Course a student will:

1. To acquire the knowledge about the fundamentals of the casting, basic terminology related to casting process.

2. To make students aware about the alternative method for the manufacturing of component for engineering applications

Course Outcomes (CO)
CO1: To identify and tabulate a list of sand properties impacting meal casting. (BT-1)
CO2: to explain and express the sand test variants, it's importance and applications. (BT-2)
CO3: To apply knowledge of gating and risering systems for making castings. (BT-3)
CO4: To illustrate the methoding system for various moulding and casting techniques.

(BT-4)
CO5: To assess casting defects, understand symptoms and to apply remedial measures. (BT-5)
CO6: To design innovative castings via understanding of feeding systems, solidification and methoding. (BT-6)

Course Outline

Proposed course mainly deal with nuances of Foundry Technology and deals with the majority of process pertaining to Foundry Processes and Metal Casting and Solidification for the production of the same, along with this, the subject deals with Quality Control and Defect Analysis for production of sound casting.

Method of delivery

Face to face lectures, Experiments in Laboratory, Model Making

Study time

3 hours of Lectures and 2 hours of Laboratories.

CO-PO Mapping (PO: Program Outcomes)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C0 1	2	1	2	1	2							2
C0 2	2	2	3	3	1	1					1	2
C0 3	2	3	3	2	2							3
C0 4	1	2	3	1	3							
C0 5	1	3	2	3	2						1	3
C0 6	2	2	2	1	2						2	2

1-Lightly Mapped 2- Moderately Mapped 3- Highly Mapped

Blooms Taxonomy and Knowledge retention

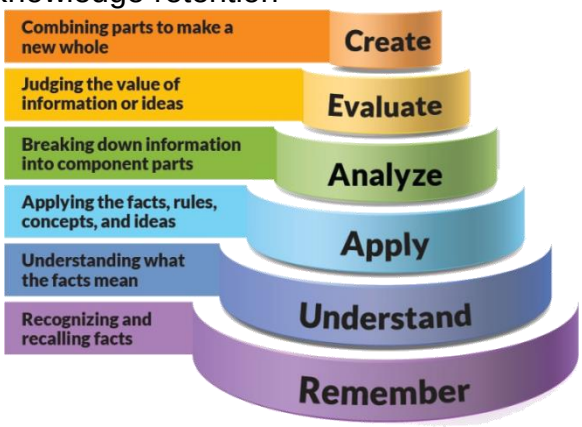


Figure 1: Blooms Taxonomy

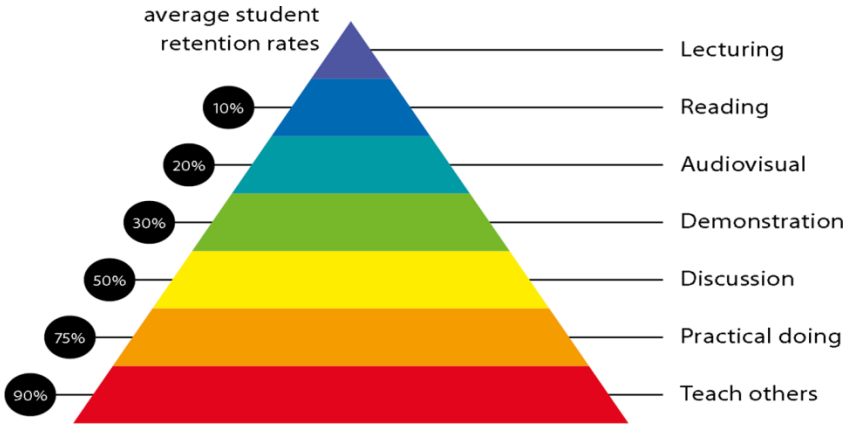


Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

General Graduate Qualities	Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**
Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking	**4 Problem solving skills**

skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communications** **6 Oral communication** **7 Teamwork**
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Practical work:

Experiment No	Title
1	Introduction to foundry laboratory.
2	To detrmine AFS fineness number and distribution coefficient of agiven sand sample
3	To demonstrate the working of sand muller
4	To determine the clay content of given sand sample
5	To prepare standard samples under identical condition for checking important physical properties of foundry sand
6	To determine compression strength of foundry sand
7	To determine permeability number of green sand,core sand and raw sand
8	To find out the green mould hardness of the sand mould
9	To determine shatter index of the sand sample.
10	To determine moisture content of the prepared sand
11	To prepare core sand
12	To findout the hardness of dried cores made out of core sands
13	To perform peelback test on core sand
14	To perform hot distortion and tensile tests on core sand
15	To study the aluminum melting and casting

Lecture/tutorial times

Lecture	Monday	12:10- 01:10 PM	Room LH 4
Lecture	Wednesday	09:00- 10:00 PM	Room LH 4
Lecture	Thursday	09:00- 10:00 PM	Room LH 4
Lab	Thursday	2:00 to 4:10 PM	Lab -04 (Ground Floor)

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the Course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for mid and end semester examinations.

Details of referencing system to be used in written work

Reference Books

1. P. C. Mukherjee, "Fundamentals of Metal Casting Technology", Oxford & IBH, 1st Edition, 1988, ISBN: 9788120403635.
2. P. R. Beeley, "Foundry Technology", Butterworth-Heinemann, 2nd Edition, 2001, ISBN: 9780750645676.
3. H. F. Taylor and M. C. Flemings, "Foundry Engineering", Wiley Eastern, 1st Edition, 1959, ISBN: 9780471848431.
4. D. Kumar and S. K. Jain, "Foundry Technology", CBS Publications, 1st Edition, 2007, ISBN: 9788123902906.

Text books

1. R. W. Heine, C. R. Loper and P. C. Rosenthal, "Principles of Metal Casting", Tata McGraw Hill, 2nd Edition, 2017, ISBN: 9780070993488.
2. P. L. Jain, "Principles of Foundry Technology", Tata McGraw Hill, 2nd Edition, 1987, ISBN: 9780074516980.

Additional Materials

1. NPTEL MOOC Course on "Principles of Casting Technology" (https://onlinecourses.nptel.ac.in/noc17_me11/preview)

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

CIE 60 marks :(40 marks mid semester examination + 20 marks internal evaluation)

Breakup of 20 Marks: (05 marks as attendance bonus for all students having attendance > 80%) + (05 marks for presentation) +(10 marks for assignment or case studies)

ESE: 40 Marks of End Semester Examination

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in mid semester or end semester will be considered for supplementary assessment in the respective components (i.e mid semester or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (mid semester or end semester) and need to obtain the required minimum 40% marks to clear the concerned components. , For remedial and repeater remedial - CIE 60 marks (40 marks remedial mid semester examination + 20 marks for assignments or case studies, limited to minimum 04 assignments per course), and end semester repeater and remedial examination would be carried out centrally according to University Policy

Practical Work Report/Laboratory Report:

Upon completion of each experiment, the student has to complete the journal and get it evaluated within a weeks' time before the next experiment is started.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of -% of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

Plagiarism - Plagiarism is not acceptable and may result in the imposition of severe penalties. Plagiarism is the use of another person's work, or idea, as if it is his or her own - if you have any doubts at all on what constitutes plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment

Course schedule (subject to change)

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Weeks 1	**General:** Introduction to metal casting and foundry industry in modern industrial scenario. Advantages and limitations of casting methods.	1,2,3	BB, PPT, OL
	Weeks 2	Classification of foundries. Different sections in a foundry and their functions. Important cast metals and alloys-their composition, properties and uses.	1,2,3	BB, PPT, OL
	Week 3	**Patternmaking:** Patterns. Types. Pattern making materials and their selection, Color code, Pattern allowances, Core-boxes and their types.	1,2,3	BB, PPT, OL
	Week 4	**Moulding and Core-making Materials:** Ingredients of common type of moulding and core-making sands, their properties and behavior, testing of sands and clay.	1,2,3	BB, PPT, OL
	Week 5	**Moulding Processes:** Classification, Brief description of processes such as green sand, dry sand, loam, floor, Pit and machine molding	1,2,3	BB, PPT, OL
	Week 6	**Casting Processes:** Shell molding and casting process, Investment casting process, Permanent molding process. Gravity and Pressure Die-casting, Centrifugal casting process. Low Pressure Die-casting (LDPC) process.	1,2,3	BB, PPT, OL
	Week 7	**Melting:** Melting of cast iron, Constructional features of Cupola, Principles and operation of Cupola furnace.	1,2,3	BB, PPT, OL
	Week 8	Advances in cupola melting operation, Melting of aluminum and Copper-based alloys. Furnaces used, Melt-	1,2,3	BB, PPT, OL

		treatments such as degassing, Grain refining and modification		
	Week 9	**Gating System:** Elements of gating system. Classification. Gating design considerations, Gating ratio. Gating practice for ferrous and non-ferrous alloys, Pouring equipments.	1,2,3	BB, PPT, OL
	Week 10	**Gating System:** Elements of gating system. Classification. Gating design considerations, Gating ratio. Gating practice for ferrous and non-ferrous alloys, Pouring equipments.	1,2,3	BB, PPT, OL
	Week 11	**Risering System:** Risering practice, Functions of riser, Directional and progressive solidification. Centerline feeding resistance. Riser efficiency. Riser design considerations. .	1,2,3	BB, PPT, OL
	Week 12	**Risering System:** Risering practice, Functions of riser, Directional and progressive solidification. Centerline feeding resistance. Riser efficiency. Riser design considerations	1,2,3	BB, PPT, OL
	Week 13	Risering curves. Cain's, N.R.L. and Modulus methods, Feeding distance and feeding aids, Blind and atmospheric risers	1,2,3	BB, PPT, OL
	Week 14	Risering curves. Cain's, N.R.L. and Modulus methods, Feeding distance and feeding aids, Blind and atmospheric risers	1,2,3	BB, PPT, OL
	Week 15	**Quality Control in Foundry:** Casting defects, their causes and remedies. Shop floor quality control tests such as composition control, Wedge test, fluidity, temperature measurement etc	1,2,3	BB, PPT, OL
	Week 16	**Quality Control in Foundry:** Casting defects, their causes and remedies. Shop floor quality control tests such as composition control, Wedge test, fluidity, temperature measurement etc	1,2,3	BB, PPT, OL

Program Mapping (Metallurgy Engineering Department)

Sem	Subjects
1st	DELA; Engineering Chemistry; Workshop; Material Science; Environmental Science; Material Science (OE); Technical English 1
2nd	Calculus; Engineering Physics; Metallurgy for Non Metallurgists (OE); Structural Properties and Physics of Materials; Engineering Graphics; Advanced Material and Application (OE); Technical English 2
3rd	Probability, Statistics and Numerical Methods; Management for Engineers; Human Values and Professional Ethics; Mineral Processing; Metallurgical Thermodynamics; Internship-I; Physical Metallurgy
4th	Iron Making; Transport Phenomena; Metal Casting and Solidification (OE); Recycled Materials (OE); Heat Treatment Principles and Practices; Soft Skill and Interpersonal Comm.; Personality Credit-1
5th	Foundry Technology; Steel Making; Fuel Furnace and Refractories (EL); Environmental Pollution and its Control in Met. Ind. (EL); Non Ferrous Extractive Metallurgy; Plastic Deformation of Metals; Energy Economy and Waste Management- (OE); Internship-2
6th	Metal Forming; Phase Transformation; Powder Metallurgy (Elective-1); Modelling of Metallurgical Processes (Elective-1); Electrometallurgy and Corrosion; Ind. Ceramics and Polymers (El-2); Nano Technology (OE); Metal Joining Processes; Composite Materials (EL-2); Personality Credit-2
7th	Metal Testing and Characterization; Alloy Design (EL); Advanced Ferrous Metallurgy (EL); Surface (EL); Internship-3; Non Destructive Testing (EL) and (OE); Material Testing and Standards; Selection of Material & Failure analysis (EL) & (OE); Advanced Foundry Technology (EL)
8th	Project

Subject: Foundry Technology								
Program: **B. Tech Metallurgical Engineering**				Subject Code: **MME0504**			Semester: **V**	
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	2	4	16/40	16/40	24/60	24/60	200

Course Objectives

1. To acquire the knowledge about the fundamentals of the casting, basic terminology related to casting process.
2. To make students aware about the alternative method for the manufacturing of component for engineering applications.

CONTENTS

UNIT-I

[10 hours]

General: Introduction to metal casting and foundry industry in modern industrial scenario. Advantages and limitations of casting methods. Classification of foundries. Different sections in a foundry and their functions. Important cast metals and alloys-their composition, properties and uses.
Patternmaking: Patterns. Types. Pattern making materials and their selection, Color code, Pattern allowances, Core-boxes and their types.

UNIT-II

[10 hours]

Moulding and Core-making Materials: Ingredients of common type of moulding and core-making sands, their properties and behavior, testing of sands and clay.
Moulding Processes: Classification, Brief description of processes such as green sand, dry sand, loam, floor, Pit and machine molding. No-bake molding process. CO_2-Silicate process.

UNIT-III

[10 hours]

Casting Processes: Shell molding and casting process, Investment casting process, Permanent molding process. Gravity and Pressure Die-casting, Centrifugal casting process. Low Pressure Die-casting (LDPC) process.
Melting: Melting of cast iron, Constructional features of Cupola, Principles and operation of Cupola furnace. Advances in cupola melting operation, Principles of Induction furnace, Melting of aluminum and Copper-based alloys. Furnaces used, Melt-treatments such as degassing, Grain refining and modification.

UNIT-IV

[10 hours]

Gating System: Elements of gating system. Classification. Gating design considerations, Gating ratio. Gating practice for ferrous and non-ferrous alloys, Pouring equipments.

Risering System: Risering practice, Functions of riser, Directional and progressive solidification. Centerline feeding resistance. Riser efficiency. Riser design considerations. Risering curves. Cain's, N.R.L. and Modulus methods, feeding distance and feeding aids, Blind and atmospheric risers
Quality Control in Foundry: Casting defects, their causes and remedies. Shop floor quality control tests such as composition control, Wedge test, fluidity, temperature measurement etc. Salvaging and Repairing of Castings

Foundry Technology Lab (List of Experiments)

Experiment No.	Title
1	Introduction to foundry laboratory.
2	To detrmine AFS fineness number and distribution coefficient of agiven sand sample
3	To demonstrate the working of sand muller
4	To determine the clay content of given sand sample
5	To prepare standard samples under identical condition for checking important physical properties of foundry sand
6	To determine compression strength of foundry sand
7	To determine permeability number of green sand,core sand and raw sand
8	To find out the green mould hardness of the sand mould
9	To determine shatter index of the sand sample.
10	To determine moisture content of the prepared sand
11	To prepare core sand
12	To findout the hardness of dried cores made out of core sands
13	To perform peelback test on core sand
14	To perform hot distortion and tensile tests on core sand
15	To study the aluminum melting and casting

Course Outcomes
1. To apply knowledge about how to manufacture the intricate casting what should be the process parameter, design of pattern, mould, etc.
2. To apply the theory about the melting practice of different cast alloy.
3. To apply the knowledge to overcome defects generated during casting.

Text Books
1. R. W. Heine, C. R. Loper and P. C. Rosenthal, “Principles of Metal Casting”, Tata McGraw Hill, 2nd Edition, 2017, ISBN: 9780070993488.
2. P. L. Jain, “Principles of Foundry Technology”, Tata McGraw Hill, 2nd Edition, 1987, ISBN: 9780074516980.

Reference Books
1. P. C. Mukherjee, “Fundamentals of Metal Casting Technology”, Oxford & IBH, 1st Edition, 1988, ISBN: 9788120403635.

2. P. R. Beeley, "Foundry Technology", Butterworth-Heinemann, 2nd Edition, 2001, ISBN: 9780750645676.
3. H. F. Taylor and M. C. Flemings, "Foundry Engineering", Wiley Eastern, 1st Edition, 1959, ISBN: 9780471848431.
4. D. Kumar and S. K. Jain, "Foundry Technology", CBS Publications, 1st Edition, 2007, ISBN: 9788123902906.

Web Resources

1. NPTEL MOOC Course on "Principles of Casting Technology" (https://onlinecourses.nptel.ac.in/noc17_me11/preview)

Name of Institute: Indus Institute of Technology & Engineering
Name of Faculty: Dr.K. Santhy

Course Code: MME0502
Course Name: Non Ferrous Extractive Metallurgy
Pre-requisites: Students must be aware about the basic concept of chemistry, Ferrous and Non-Ferrous metal.
Credit points: 03
Offered Semester: V

Course Coordinator (weeks 01–15)
Full Name: Dr.K. Santhy
Department with sitting location: 3rd Floor, Staff room
Telephone: 9787710922
Email: santhy.mt@indusuni.ac.in
Consultation times: 4:15 PM – 5:00 PM

Course Lecturer (weeks 01–15)
Full Name: Dr.K. Santhy
Department with sitting location: 3rd Floor, Staff room
Telephone: 9787710922
Email: santhy.mt@indusuni.ac.in
Consultation times: 4:15 PM – 5:00 PM

Students will be contacted throughout the session personally via e-mail with important information relating to this course.

Course Objectives

1. To make the students aware about basics of non-ferrous metals and its extraction processes.
2. To impart the knowledge about the basic steps followed in extraction and their importance.

Course Outcomes (CO)

CO1. To apply the knowledge regarding the auxiliary operation and the advancement in various extractive process.
CO2. The fundamental understanding of principles of extraction.
CO3. Awareness about modern extraction and refining techniques in production of copper, zinc, aluminum, titanium, uranium, thorium and zirconium.
CO4. To apply the theory about the extraction practice of different non-ferrous metals.

Course Outline

The course will discuss the theoretical and practical aspects of extraction of nonferrous metals. The various methods will be considered for beneficiation, extraction and refining of nonferrous metals. The course will highlight the energy and environmental aspects of extraction processes.

Method of delivery

Online lectures

Study time

3 Hour Lecture per week

CO-PO Mapping (PO: Program Outcomes)

Mapping CO's with PO's

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	1	1	1	1	3	2	1	2
CO2	3	3	3	3	1	1	1	1	3	1	1	2
CO3	3	1	1	3	2	1	1	1	3	1	1	2
CO4	3	3	2	3	2	1	1	1	3	1	1	2

1-Lightly Mapped 2- Moderately Mapped 3- Highly Mapped

Blooms Taxonomy and Knowledge retention (For reference)

(Blooms taxonomy has been given for reference)

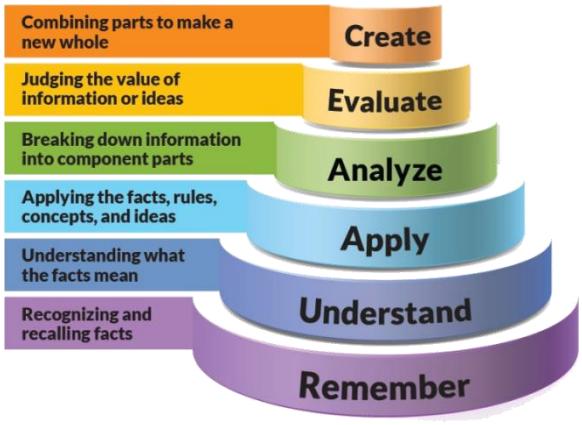


Figure 1: Blooms Taxonomy

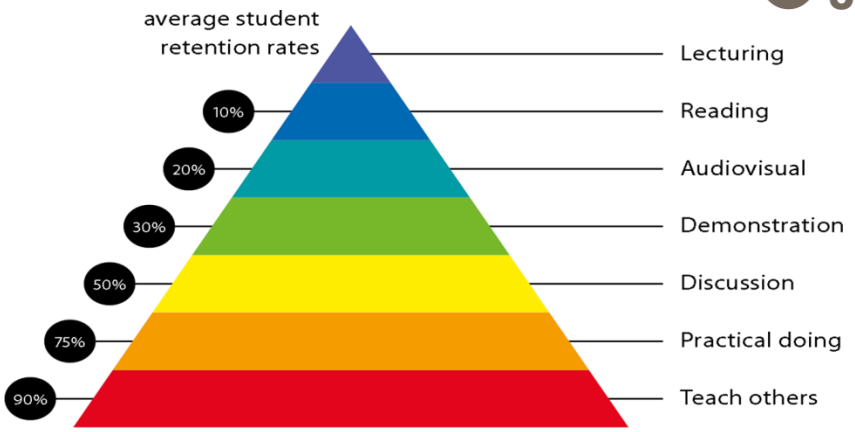


Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of _____Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**
Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	**4 Problem solving skills**
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communication** **6 Oral communication** **7 Teamwork**

Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Practical work:

(Mention what practical work this Course involves)

NA

Lecture/tutorial times

Lecture Monday	2.00 – 3.00 PM	Online
Lecture Wednesday	10.00 – 11.00 AM	Online
Lecture Thursday	10.00 – 11.00 AM	Online

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the Course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for mid and end semester examinations.

Details of referencing system to be used in written work

Text books

1. H.S. Ray, R. Sridhar and K.P. Abraham, “Extraction of Nonferrous Metals”, Affiliated East West Press Pvt Ltd, 1st Edition, 2008, ISBN: 9788185095639.

Additional Materials

Reference Books

1. W. H. Dennis, “Extractive Metallurgy”, Pitman Publishing, 1st Edition, 1965, ISBN: 9780273404729.
2. F. Habashi, “Principles of Extractive Metallurgy”, Gordon & Breach, 1st Edition, 1970, ISBN: 9780677017808.
3. T. Rosenqvist, “Principles of Extractive Metallurgy”, McGraw Hill, 1st Edition, 1974, ISBN: 9780070538474.
4. J. L. Bray, “Nonferrous Production Metallurgy”, John Wiley and Sons, 2nd Edition, 1947, ASIN: B0007E2TW6.

5. R. D. Pehlke, “Unit Processed in Extractive Metallurgy”, Elsevier, 1st Edition, 1973, ISBN: 9780444001306.
6. H. S. Ray, “Introduction to Melts: Molten Salts, Slags and Glasses”, Allied Publishers Pvt Ltd 1st Edition, 2006, ISBN: 9788177648751.
7. H.S. Ray, B.P Singh, S. Bhattacharjee and V. N. Misra, “Energy in Minerals and Metallurgical Industries”, Allied Publishers Pvt Ltd, 1st Edition, 2005, ISBN: 8177648748.
8. H. S. Ray and A. Ghosh, “Principles of Extractive Metallurgy”, New Age Publishers, 2nd Edition, 1991, ISBN: 9788122403220.

Web Resources

1. NPTEL Course on “Non-Ferrous Extractive Metallurgy” (http://nptel.ac.in/courses/113105021/)

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

MSE	40%
Assignment	10%
Attendance	5%
Class Interaction	5%
Final exam (*closed book*)	40%

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in mid semester or end semester will be considered for supplementary assessment in the respective components (i.e., mid semester or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (mid semester or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Practical Work Report/Laboratory Report:

A report on the practical work is due the subsequent week after completion of the class by each group.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of -% of the maximum mark per calendar day.

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

Plagiarism - Plagiarism is not acceptable and may result in the imposition of severe penalties. Plagiarism is the use of another person's work, or idea, as if it is his or her own - if you have any doubts at all on what constitutes plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

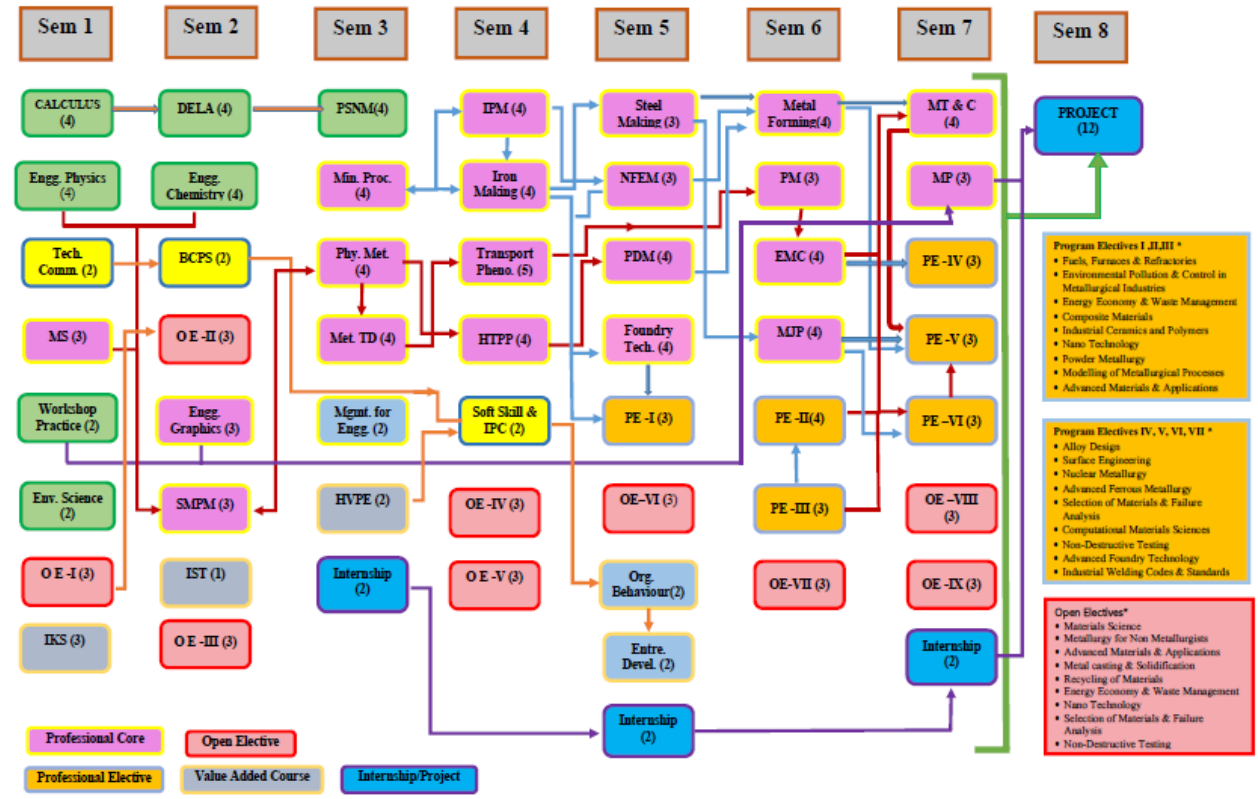
Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment).

Course schedule

Weeks	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
Week01	**General**: World resources of Non-ferrous metals and their occurrence. Present and future position of non-ferrous metallurgical industry in India-resources, production and consumption.	CO1	Interactive teaching using PPT and google meet
Week02	Indian scenario of non-ferrous ores and mineral deposits. Production plants for non-ferrous metals such as copper, zinc, lead, tin, Aluminum, nickel, magnesium, titanium, etc. Problem Solving	CO1	Interactive teaching using PPT and google meet
Week 03	Basics of Pyro metallurgy, Hydrometallurgy and electrometallurgy	CO1, CO2	Interactive teaching using PPT and google meet
Week 04	**Aluminum:** Occurrence of Bauxite. Bayer's process for production of alumina. Alternatives to Bayer's process. Hall-Heroult process-conventional and new materials for construction of Aluminum reduction cell, nature of electrolyte.	CO1, CO2	Interactive teaching using PPT and google meet
Week 05	Electrolysis of alumina with emphasis on physico-chemical principles and secondary-reactions, factors affecting current efficiency. Alternatives to Hall-Heroult process. Refining of Aluminum.	CO1, CO2	Interactive teaching using PPT and google meet

Week 06	**Copper**: Occurrence of copper ores. Roasting. Matte-smelting, Converting and Refining process as applied to copper production and their physico-chemical aspects.	CO1, CO2	Interactive teaching using PPT and google meet
Week 07	Single step and multistep continuous processes. Hydrometallurgical process for production of primary copper. Recovery of copper from copper slag.	CO1, CO2	Interactive teaching using PPT and google meet
Week 08	**Nickel:** Occurrence of nickel ores, Pyrometallurgical and Hydrometallurgical processes for nickel production and refining.	CO1, CO2	Interactive teaching using PPT and google meet
Week 09	**Lead and Zinc:** Occurrence of lead and zinc ores, Pyrometallurgical and Hydrometallurgical processes for lead and zinc	CO1, CO2	Interactive teaching using PPT and google meet
Week 10	production and their physio-chemical aspects, Refining of lead and zinc, Recovery of byproducts.	CO1, CO2	Interactive teaching using PPT and google meet
Week 11	**Tin**: Occurrence of tin, various methods of extraction of tin from its ores and other sources. Uses of tin.	CO1, CO2	Interactive teaching using PPT and google meet
Week 12	**Gold and Silver**: Occurrence of gold and silver. Various methods for production of gold and silver from their ores and other sources. Problem Solving	CO1, CO2	Interactive teaching using PPT and google meet
Week 13	Recovery of gold, silver and platinum from secondary sources such as Copper Anode Mud, Red Mud, Zinc dross and electrolytic solutions. Problem Solving	CO1, CO2, CO4	Interactive teaching using PPT and google meet
Week 14	**Magnesium**: Occurrence of magnesium, Methods of production of magnesium oxide and magnesium chloride, Pyrometallurgical extraction of magnesium, Electrolytic extraction and refining of magnesium.	CO1, CO2, CO4	Interactive teaching using PPT and google meet
Week 15	**Titanium**: Occurrence of titanium, Extraction, Production, recovery, properties and application.	CO1, CO2, CO3	Interactive teaching using PPT and google meet

B. Tech Materials and Metallurgical Engineering Course Flowchart (IITE, Indus University)



Subject: Non Ferrous Extractive Metallurgy								
Program: **B. Tech in Metallurgical Engineering**				Subject Code: **MME0502**			Semester: **V**	
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	0	3	16/40	0	24/60	0	100

Course Objectives

1. To make the students aware about basics of non-ferrous metals and its extraction processes.
2. To impart the knowledge about the basic steps followed in extraction and their importance.

CONTENTS

UNIT-I

[10 hours]

General:

World resources of Non-ferrous metals and their occurrence. Present and future position of non-ferrous metallurgical industry in India- resources, production and consumption.

Indian scenario of non-ferrous ores and mineral deposits. Production plants for non-ferrous metals such as copper, zinc, lead, tin, Aluminum, nickel, magnesium, titanium, etc.

Basics of Pyrometallurgy, Hydrometallurgy and electrometallurgy

UNIT-II

[10 hours]

Aluminum:

Occurrence of Bauxite. Bayer's process for production of alumina. Alternatives to Bayer's process. Hall-Heroult process-conventional and new materials for construction of Aluminum reduction cell, nature of electrolyte. Electrolysis of alumina with emphasis on physico-chemical principles and secondary-reactions, factors affecting current efficiency. Alternatives to Hall-Heroult process. Refining of Aluminum.

Copper:

Occurrence of copper ores. Roasting. Matte-smelting, Converting and Refining process as applied to copper production and their physico-chemical aspects. Single step and multistep continuous processes. Hydrometallurgical process for production of primary copper. Recovery of copper from copper slag.

UNIT-III

[10 hours]

Nickel:

Occurrence of nickel ores, Pyrometallurgical and Hydrometallurgical processes for nickel production and refining.

Lead and Zinc:

Occurrence of lead and zinc ores, Pyrometallurgical and Hydrometallurgical processes for lead and zinc production and their physio-chemical aspects, Refining of lead and zinc, Recovery of byproducts.

Tin:
Occurrence of tin, various methods of extraction of tin from its ores and other sources. Uses of tin.

UNIT-IV

[10 hours]

Gold and Silver:
Occurrence of gold and silver. Various methods for production of gold and silver from their ores and other sources.
Recovery of gold, silver and platinum from secondary sources such as Copper Anode Mud, Red Mud, Zinc dross and electrolytic solutions.

Magnesium:
Occurrence of magnesium, Methods of production of magnesium oxide and magnesium chloride, Pyrometallurgical extraction of magnesium, Electrolytic extraction and refining of magnesium.

Titanium
Occurrence of titanium, Extraction, Production, recovery, properties and application.

Course Outcomes

1. To apply the knowledge regarding the auxiliary operation and the advancement in various extractive process.
2. To apply the theory about the extraction practice of different non-ferrous metals.

Text Books

1. H.S. Ray, R. Sridhar and K.P. Abraham, "Extraction of Nonferrous Metals", Affiliated East West Press Pvt Ltd, 1st Edition, 2008, ISBN: 9788185095639.

Reference Books

1. W. H. Dennis, "Extractive Metallurgy", Pitman Publishing, 1st Edition, 1965, ISBN: 9780273404729.
2. F. Habashi, "Principles of Extractive Metallurgy", Gordon & Breach, 1st Edition, 1970, ISBN: 9780677017808.
3. T. Rosenqvist, "Principles of Extractive Metallurgy", McGraw Hill, 1st Edition, 1974, ISBN: 9780070538474.
4. J. L. Bray, "Nonferrous Production Metallurgy", John Wiley and Sons, 2nd Edition, 1947, ASIN: B0007E2TW6.
5. R. D. Pehlke, "Unit Processed in Extractive Metallurgy", Elsevier, 1st Edition, 1973, ISBN: 9780444001306.
6. H. S. Ray, "Introduction to Melts: Molten Salts, Slags and Glasses", Allied Publishers Pvt Ltd 1st Edition, 2006, ISBN: 9788177648751.
7. H.S. Ray, B.P Singh, S. Bhattacharjee and V. N. Misra, "Energy in Minerals and Metallurgical Industries", Allied Publishers Pvt Ltd, 1st Edition, 2005, ISBN: 8177648748.
8. H. S. Ray and A. Ghosh, "Principles of Extractive Metallurgy", New Age Publishers, 2nd Edition, 1991, ISBN: 9788122403220.

Web Resources

1. NPTEL Course on "Non-Ferrous Extractive Metallurgy"
(http://nptel.ac.in/courses/113105021/)

Name of Institute : **Indus Institute of Technology & Engineering**
Name of Faculty : **Mechanical Engineering**

Course code : **BB0521**
Course name : **Organizational Behaviour**
Pre-requisites : Fundamentals of organization
Credit points : 2
Offered Semester :V

Course Coordinator

Full Name : Prof. Bhavik Soneji
Dept & Location : Department of Mechanical Engineering,
Drawing Hall-4, 3rd Floor,
Bhanwar Building,
Indus University.
Telephone 9427522362
Email : bhaviksoneji.me@indusuni.ac.in
Consultation times : 9 AM to 5 PM

Course lecturer

Full Name : Prof. Bhavik Soneji
Dept & Location : Department of Mechanical Engineering,
Drawing Hall-4, 3rd Floor,
Bhanwar Building,
Indus University.
Telephone 9427522362
Email : bhaviksoneji.me@indusuni.ac.in
Consultation times : 9 AM to 5 PM

Students will be contacted throughout the session via mail and google classroom with important information relating to this course.

Course objectives

1. To familiarize the students about the different aspects of managing people in the organization.
2. To acquaint the student with the determinants of intra -individual, inter-personnel and inter-group behavior in organizational setting.
3. To equip students with behavioral skills in managing people at work.

Course outcomes

CO1: To understand the theoretical underpinnings of organizational behavior as a discipline. (BT-1)
CO2: To Recognize the various forms of political activity and to determine when such activity is positive or negative. (BT-2)
CO3: To Use a structure group diagnostic model to analyze and resolve group/team performance problems. (BT-3)
CO4: To Recognize when conflict is good and to properly select a conflict resolution strategy when conflict is dysfunctional. (BT-4)
CO5: Draw upon various motivational theories to design a motivational program. (BT-5)
CO6: Develop and use a systematic/structured approach to solve organizational problems. (BT-6)

Course Outline

Unit: I
Introduction: Organizational Behavior- Concept and Emergence of OB Concept; Nature and Theoretical frameworks; Disciplines contributing to the field of OB; Historical Background- Hawthorne Studies, Psychological foundations; Models of Organizational Behavior, Challenges and Opportunities for Organizational Behavior.

Unit: II
Individual Behavior: Personality, Learning, Values and Attitudes, Perception, Learning Behaviorist, cognitive and social learning; Stress at work. Management's assumptions about people- McGregor's Theory X and Theory Y. Motivation - Maslow's Need Hierarchy, Herzberg's Two Factors Theory ; Theory of Intrinsic Motivation by Ken Thomas; Work –Designing for creating motivating Jobs; OB Mod.

Unit:III
Group Behaviour: Group Dynamics, Cohesiveness and Productivity; Management of Dysfunctional groups; Group Decision Making; Organizational Politics. Leadership- Concept and Styles; Fielder's Contingency Model; House's Path -Goal Theory; Leadership Effectiveness; Sources, patterns, levels, and types of conflict; Traditional and modern approaches to conflict; Functional and dysfunctional conflicts; Resolution of conflict.

Unit:IV
Case Studies: Some cases of real business world to supplement learning from the course.

Method of delivery
Lectures -Online (Chalk & talk, PPT)
Video lectures for some relevant topics

Study time
2 hours for Lectures per week

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	-	-	-	-	-	-	-	-	1
CO2	3	2	3	1	3	-	-	-	-	-	-	-
CO3	3	2	2	2	3	-	-	-	-	-	-	-
CO4	1	2	2	1	1	-	-	-	-	-	-	-
CO5	2	3	1	2	1	-	-	-	-	-	-	-
CO6	1	3	1	2	-	-	-	-	-	-	-	-

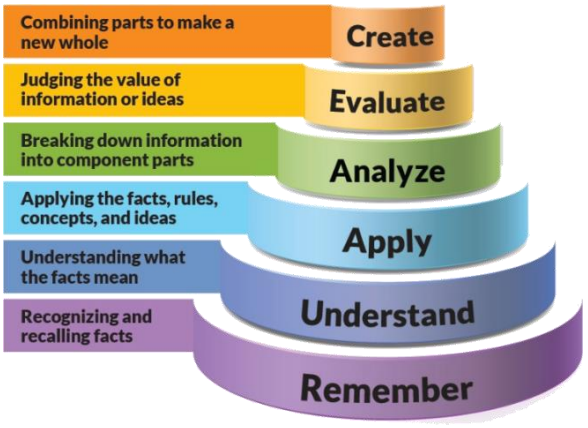


Figure 1: Blooms Taxonomy

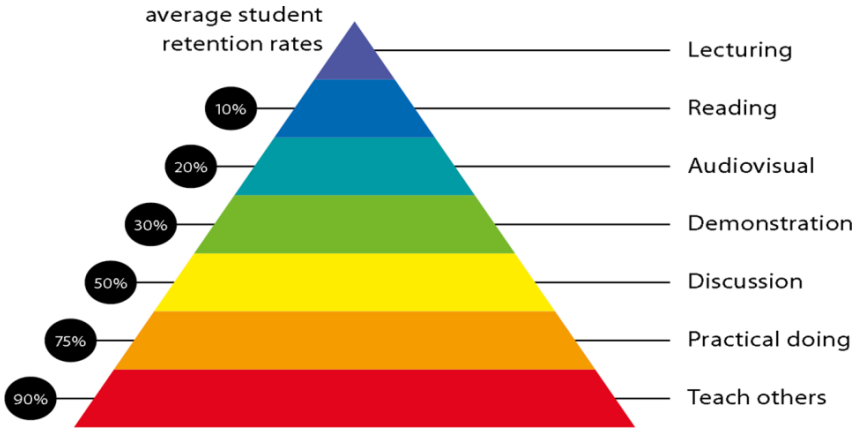


Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of_____Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**

Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	**4 Problem solving skills**
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings.	**5 Written communication** **6 Oral communication** **7 Teamwork**
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Practical work:
NIL

Lecture/tutorial times
(Give lecture times in the format below)

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for semester examinations.

Text books

1. 1. K. Ashwathappa: Organizational behavior [12th Revised edition 2016], Himalaya Publishing House.

Additional Materials

1. Robbins: Organizational Behavior:[International Edition 11], Prentice Hall
2. Michael Drafke, Human Side of Organizations [International Edition 10], Pearson Education,New Delhi.
3. R.S. Dwivedi: HUMAN RELATIONS AND ORGANISATIONAL BEHAVIOUR, 5th Edition, Macmillan India Limited, New Delhi.
4. Hellriegel, Slocum & Woodman: ORGANISATIONAL BEHAVIOUR, Thomson South- Western, New Delhi.
5. Bohlander, Snell, Sherman: MANAGING HUMAN RESORUCES, Thomson – South Western
6. Monappa, Arun &Sayiadain, Mirza (1979) Personal Management, New Delhi: Tata McGraw Hill.
7. Beardwell, Ian & Holden, Len (1986) Human Resource Management: A Contemporary Prospective, New Delhi: McMillan

ASSESSMENT GUIDELINES
Your final course mark will be calculated from the following:
(a) CIE 60 marks (40 marks mid semester examination + 20 marks internal evaluation)
Components of internal evaluation need to include
(05 marks as attendance bonus for all students having attendance > 80%) + (05 marks for presentation) + (10 marks for assignment or case studies, limited to minimum 02 assignments per course).
(b) End Semester 40 marks.

SUPPLEMENTARY ASSESSMENT
Students who receive an overall mark less than 40% in internal component or less than 40% in the end semester will be considered for supplementary assessment in the respective components (i.e internal component or end semester) of semester concerned. Students must make they available during the supplementary examination period to take up the respective components (internal component or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of -% of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

Plagiarism - Plagiarism is not acceptable and may result in the imposition of severe penalties. Plagiarism is the use of another person's work, or idea, as if it is his or her own - if you have any doubts at all on what constitutes plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment)

Unit: I

Introduction: Organizational Behavior- Concept and Emergence of OB Concept; Nature and Theoretical frameworks; Disciplines contributing to the field of OB; Historical Background- Hawthorne Studies, Psychological foundations; Models of Organizational Behavior, Challenges and Opportunities for Organizational Behavior.

Unit: II

Individual Behavior: Personality, Learning, Values and Attitudes, Perception, Learning Behaviorist, cognitive and social learning; Stress at work. Management's assumptions about people- McGregor's Theory X and Theory Y. Motivation - Maslow's Need Hierarchy, Herzberg's Two Factors Theory ; Theory of Intrinsic Motivation by Ken Thomas; Work –Designing for creating motivating Jobs; OB Mod.

Unit:III

Group Behaviour: Group Dynamics, Cohesiveness and Productivity; Management of Dysfunctional groups; Group Decision Making; Organizational Politics. Leadership- Concept and Styles; Fielder's Contingency Model; House's Path -Goal Theory; Leadership Effectiveness; Sources, patterns, levels, and types of conflict; Traditional and modern approaches to conflict;

Functional and dysfunctional conflicts; Resolution of conflict.

Unit:IV

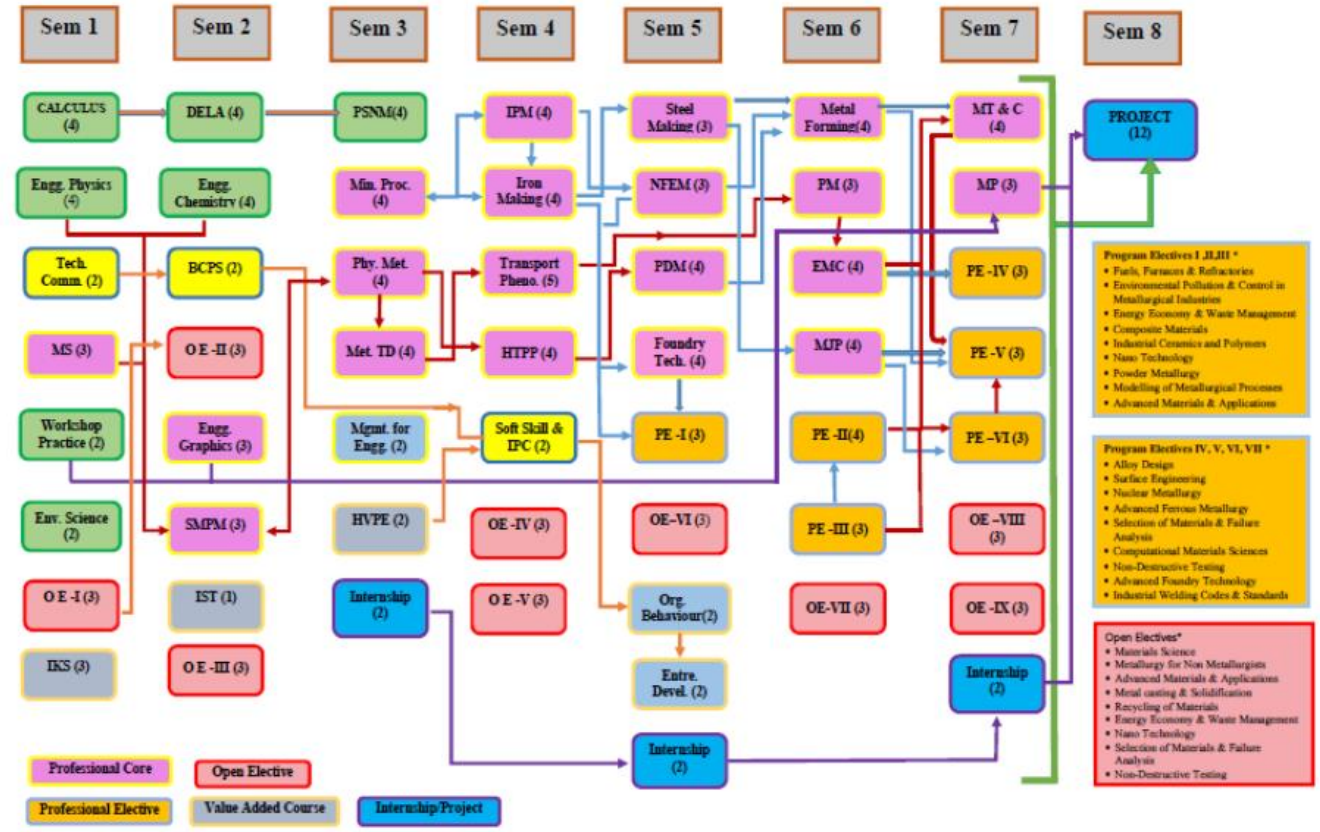
Case Studies: Some cases of real business world to supplement learning from the course.

Course schedule

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Week 1	**Unit: I** Introduction: Organizational Behavior- Concept and Emergence of OB Concept	CO-1,2	online , PPT
	Week 2	Nature and Theoretical frameworks; Disciplines contributing to the field of OB	CO-2	Lecture
	Week 3	Historical Background- Hawthorne Studies, Psychological foundations; Models of Organizational Behavior	CO-3,1	online, chalk and talk , PPT
	Week 4	Challenges and Opportunities for Organizational Behavior.	CO-1,3	online & Tutorial
	Week 5	**Unit: II** Individual Behavior: Personality, Learning, Values and Attitudes, Perception, Learning Behaviorist, cognitive and social learning; Stress at work Class Test-1	CO-1,3	Lecture & Tutorial
	Week 6	. Management's assumptions about people- McGregor's Theory X and Theory Y	CO-1,2	Lecture , chalk and talk , PPT
	Week 7	Theory of Intrinsic Motivation by Ken Thomas; Work –Designing for creating motivating Jobs; OB Mod.	CO-1,3	Lecture & Tutorial
	Week 8	**Unit:III** Group Behaviour: Group Dynamics, Cohesiveness and Productivity; Management of Dysfunctional groups; Group Decision Making	CO-1,3	Lecture , chalk and talk , PPT
	Week 9	Organizational Politics. Leadership- Concept and Styles; Fielder's Contingency Model; House's Path - Goal Theory	CO-1,2	Lecture & Tutorial

	Week 10	Leadership Effectiveness; Sources, patterns, levels, and types of conflict	CO-1,2	Lecture & Tutorial
	Week 11	and types of conflict; Traditional and modern approaches to conflict	CO-1,3	Lecture , chalk and talk , PPT
	Week 12	**Unit:IV** Case Studies: Some cases of real business world to supplement learning from the course.	CO-1,3	Lecture & Tutorial

B. Tech Materials and Metallurgical Engineering Course Flowchart (IITE, Indus University)



Name of Institute: Institute of Technology and Engineering
Name of Faculty: Dr.K. Santhy

Course code: MME0503
Course name: Plastic Deformation of Metals
Pre-requisites: Structural Metallurgy and Physics of Materials
Credit points: 4
Offered Semester: 5th

Course Coordinator (weeks XX - XX)
Full Name: Dr.K. Santhy
Department with siting location: Third Floor Staff Room
Telephone: 97877 10922
Email: santhyk.mt@indusuni.ac.in
Consultation times: 4.15-5.00PM

Course Lecturer (weeks xx - XX)
Full name:Dr.K. Santhy
Department with siting location: Third Floor Staff Room
Telephone:9787710922
Email: santhyk.mt@indusuni.ac.in
Consultation times: 4.15-5.00PM

Students will be contacted throughout the Session via Mail with important information relating to this Course.

Course Objectives
By participating in and understanding all facets of this Course a student will:

1) To provide knowledge about the basic concept crystals their structures and their defects that is point, line, volume and surface defects.
2) To teach them basics about dislocations and how dislocations helps in improving properties.
3) To teach them various strengthening mechanism of metals.

Course Outcomes (CO)
1) To solve different numerical pertaining to resolved shear stress and hall pitch equation.
2) To apply the concepts of fracture mechanics like ductile and brittle fracture.
3) To apply the theory about testing, creep and fatigue testing in practice.
4) To solve practical example on the testing.

Course Outline
(Key in topics to be dealt)
Introduction and influence of dislocation in plastic deformation

Strengthening Mechanism
Fatigue
Creep

Method of delivery
Interactive lectures using block board and power point, Demonstration of testing procedure

Study time
5 classes per week

CO-PO Mapping (PO: Program Outcomes)

CO 1: PO 1
CO 2: PO 1, 2
CO 3: PO 2
CO 4: PO 4

Blooms Taxonomy and Knowledge retention (For reference)
(Blooms taxonomy has been given for reference)

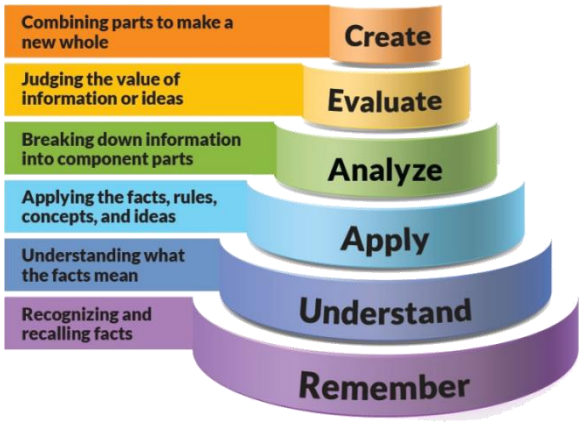


Figure 1: Blooms Taxonomy

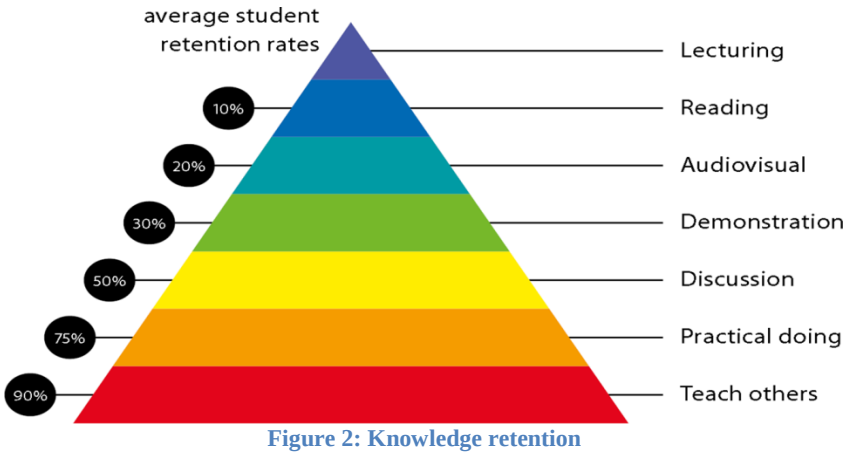


Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Specific Department of _____Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**
Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies. Acknowledge the work and ideas of others.	**2 Information literacy, gathering & processing**
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	**4 Problem solving skills**
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communication**
	6 Oral communication
	7 Teamwork
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Practical work:

(Mention what practical work this Course involves)

Lecture/tutorial times

(Give lecture times in the format below)

Example:

Lecture	Tuesday	10.00 – 11.00 am	Online
Lecture	Wednesday	12.20 – 1.20 pm	Online
Tutorial	Friday	10.00 – 11.00 am	Online
Lecture	Friday	2.00 – 3.00 pm	Online

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the Course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for mid and end semester examinations.

Details of referencing system to be used in written work

Text books

1. G. E. Dieter, "Mechanical Metallurgy", McGraw-Hill, 3rd Edition, 2013, ISBN: 9781259064791.
2. R. Abbaschian, L. Abbaschian and R. E. Reed-Hill, "Physical Metallurgy Principles", Stamford CT: Cengage Learning, 4th Edition, 2010, ISBN: 9780495438519.
3. R. W. Hortzberg, "Deformation and Fracture Mechanics of Engineering Materials", John Wiley and Sons, 5th Edition, 2012, ISBN: 9780470527801.
4. J. Wulff, H. W. Hayde and W. I. Moffatt, "Structure and Properties of Materials Vol.III: Mechanical Behaviour", John Wiley and Sons, 1st Edition, 1967, ASIN: B000N91X72.

Additional Materials

1. T. H. Courtney, "Mechanical Behavior of Materials", Waveland Pr Inc, 2nd Edition, 2005, ISBN: 9781577664253.
2. A. V. K. Suryanarayan, "Testing of Metallic Materials", BS Publications, 1st Edition, 2007, ISBN: 9788178001340
3. NPTEL MOOC Course on "Introduction to Crystal Elasticity and Crystal Plasticity" (https://onlinecourses.nptel.ac.in/noc16_mm13/preview)
4. EdX Online Course on "Mechanical Behavior of Materials" (https://courses.edx.org/courses/MITx/3.032x/3T2014/info)
5. NPTEL MOOC Course on "Fundamentals of Material Processing - I" (https://onlinecourses.nptel.ac.in/noc17_mm09/preview)
6. NPTEL MOOC Course on "Fundamentals of Material Processing - I" (https://onlinecourses.nptel.ac.in/noc16_mm11/preview)
7. EdX Online Course on "Fundamentals of Manufacturing Processes" (https://www.edx.org/course/fundamentals-manufacturing-processes-mitx-2-008x)

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

Example:		
MSE	40%	
Assignment	10%	
Attendance	5%	
Class Interaction	5%	
Final exam (*closed book*)	40%	Objectives (1-5)

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in mid semester or end semester will be considered for supplementary assessment in the respective components (i.e mid semester or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (mid semester or end semester) and need to obtain the required minimum 40% marks to clear the concerned components.

Practical Work Report/Laboratory Report:

A report on the practical work is due the subsequent week after completion of the class by each group.

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of 10% of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

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Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment)

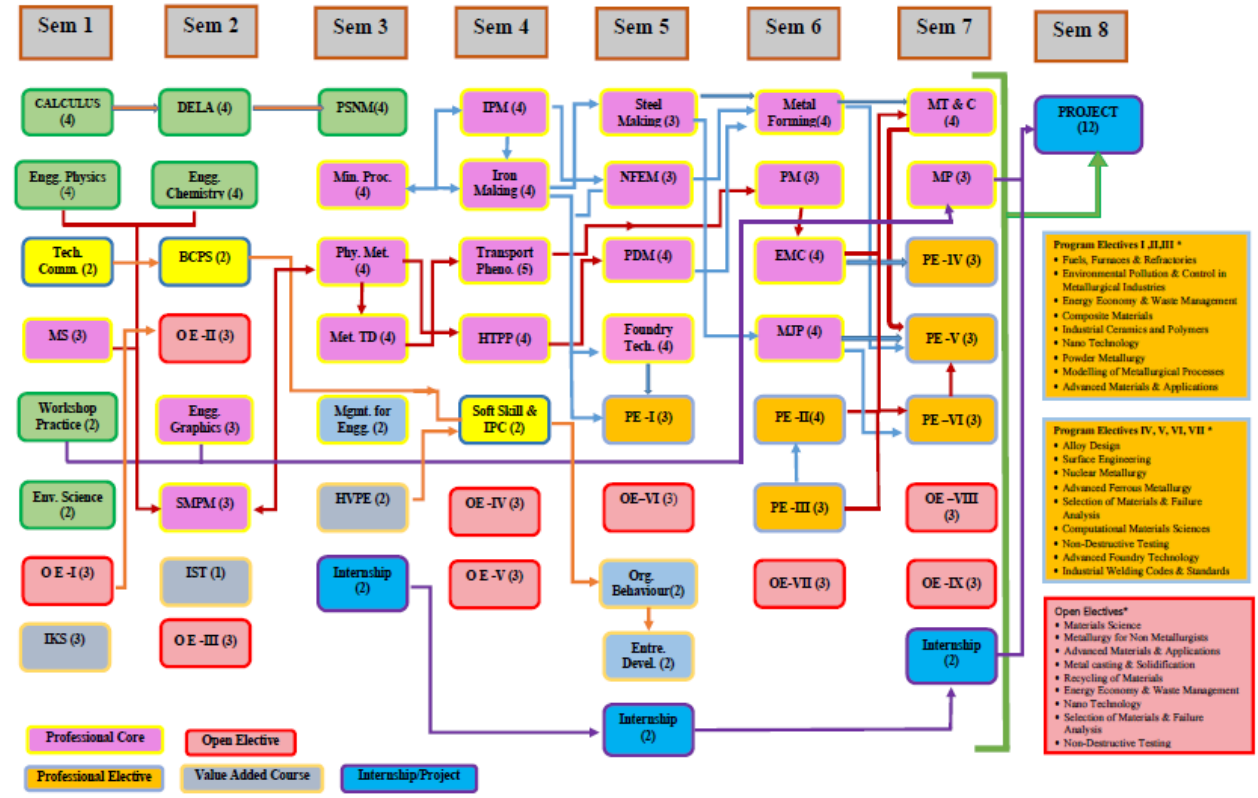
Course schedule (subject to change)

(Mention quiz, assignment submission, breaks etc as well in the table under the Teaching Learning Activity Column)

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Weeks 1	Crystal Imperfections, Point Defects, Line Defects & Surface Defects, Dislocation and its types, Slip Phenomena, Slip Systems.	1	Interactive teaching using PPT and google meet
	Weeks 2	Theoretical strength of a perfect Crystal, Slip by dislocation movement, concept of critical resolved shear stress,	1	Interactive teaching using PPT and google meet
	Week 3	Climb and its types, Twinning as a mode of deformation, Burgers vector and the dislocation loop, Stress fields and energies of dislocations, Jogs and Kinks.	*1*	Interactive teaching using PPT and google meet
	Week 4	Dislocation in F.C.C (including formation of stacking fault.) B.C.C and H.C.P., Multiplication of dislocations,	1	Interactive teaching using PPT and google meet
	Week 5	Techniques to observe dislocation, Dislocation point defects interactions, , Intersection of Dislocations, Dislocations pile up.	1	Interactive teaching using PPT and google meet
	Week 6	Deformation of single and polycrystalline materials, Grain boundaries. Low-angle boundaries, High Angle Grain Boundaries Surface tension of the grain boundary, Strengthening from grain boundaries, Hall-petch equation, Yield point phenomenon.	*1*	Interactive teaching using PPT and google meet
	Week 7	Strain- hardening of polycrystalline metals, Strain hardening of single crystals, Relation between single and polycrystalline stress-strain curve, Solid – Solution hardening.	1,2	Interactive teaching using PPT and google meet
	Week 8	Strengthening due to second phase particles, Strain – ageing behavior, annealing of cold-worked metals, Recovery, Recrystallization and grain growth.	1,2	Interactive teaching using PPT and google meet

	Week 9	All types of test, Modes of Failure, Theory of ductile-brittle transition temperature (DBTT).	*1,2*	Interactive teaching using PPT and google meet
	Week 10	Types of fracture in metals. Theoretical cohesive strength of metals. Griffith theory of brittle fracture, Elementary concept of fracture mechanics,	1	Interactive teaching using PPT and google meet
	Week 11	Fatigue test. Theory of fatigue. Effect of metallurgical variables and temperature.	2,4	Interactive teaching using PPT and google meet
	Week 12	Creep test, Creep curve. Stress-rupture test, Creep mechanisms. High temperature alloys.	2,4	Interactive teaching using PPT and google meet
	Week 13	Effect of some metallurgical variables. Presentation of engineering creep data.	2	Interactive teaching using PPT and google meet

B. Tech Materials and Metallurgical Engineering Course Flowchart (IITE, Indus University)



Subject: **Plastic Deformation of Metals**								
Program: **B. Tech in Metallurgical Engineering**				Subject Code: **MME0503**			Semester: **V**	
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	1	0	4	16/40	0	24/60	0	100

Course Objectives

1. To provide knowledge about the basic concept crystals their structures and their defects that is point, line, volume and surface defects.
2. To teach them basics about dislocations and how dislocations help in improving properties.
3. To teach them various strengthening mechanism of metals.

CONTENTS

UNIT-I

[10 hours]

Crystal Imperfections, Point Defects, Line Defects & Surface Defects, Dislocation and its types, Slip Phenomena, Slip Systems. Theoretical strength of a perfect Crystal, Slip by dislocation movement concept of critical resolved shear stress, Climb and its types, Twinning as a mode of deformation, Burgers vector and the dislocation loop, Stress fields and energies of dislocations, Jogs and Kinks.

UNIT-II

[10 hours]

Dislocation in F.C.C (including formation of stacking fault.) B.C.C and H.C.P., Forces. Multiplication of dislocations, Techniques to observe dislocation, Dislocation point defects interactions, Intersection of Dislocations, Dislocations pile up.

Deformation of single and polycrystalline materials, Grain boundaries. Low-angle boundaries, High Angle Grain Boundaries Surface tension of the grain boundary, Strengthening from grain boundaries, Hall-petch equation, Yield point phenomenon.

UNIT-III

[10 hours]

Strain- hardening of polycrystalline metals, Strain hardening of single crystals, Relation between single and polycrystalline stress-strain curve, Solid – Solution hardening. Strengthening due to second phase particles, Strain – ageing behavior, annealing of cold-worked metals, Recovery, Recrystallization and grain growth.

All types of tests, Modes of Failure, Theory of ductile-brittle transition temperature (DBTT).

UNIT-IV

[10 hours]

Types of fracture in metals. Theoretical cohesive strength of metals. Griffith theory of brittle fracture, Elementary concept of fracture mechanics, Fatigue test. Theory of fatigue. Effect of metallurgical variables and temperature. Creep test, Creep curve. Stress-rupture test, Creep mechanisms. High temperature alloys. Effect of some metallurgical variables. Presentation of engineering creep data.

Course Outcomes

1. To solve different numerical pertaining to resolved shear stress and hall pitch equation.

2. To apply the concepts of fracture mechanics like ductile and brittle fracture.
3. To apply the theory about testing, creep and fatigue testing in practice.
4. To solve practical example on the testing.

Text Books

1. G. E. Dieter, "Mechanical Metallurgy", McGraw-Hill, 3rd Edition, 2013, ISBN: 9781259064791.
2. R. Abbaschian, L. Abbaschian and R. E. Reed-Hill, "Physical Metallurgy Principles", Stamford CT: Cengage Learning, 4th Edition, 2010, ISBN: 9780495438519.
3. R. W. Hortzberg, "Deformation and Fracture Mechanics of Engineering Materials", John Wiley and Sons, 5th Edition, 2012, ISBN: 9780470527801.
4. J. Wulff, H. W. Hayde and W. I. Moffatt, "Structure and Properties of Materials Vol.III: Mechanical Behaviour", John Wiley and Sons, 1st Edition, 1967, ASIN: B000N91X72.

Reference Books

1. T. H. Courtney, "Mechanical Behavior of Materials", Waveland Pr Inc, 2nd Edition, 2005, ISBN: 9781577664253.
2. A. V. K. Suryanarayan, "Testing of Metallic Materials", BS Publications, 1st Edition, 2007, ISBN: 9788178001340.

Web Resources

1. NPTEL MOOC Course on "Introduction to Crystal Elasticity and Crystal Plasticity" (https://onlinecourses.nptel.ac.in/noc16_mm13/preview)
2. EdX Online Course on "Mechanical Behavior of Materials" (https://courses.edx.org/courses/MITx/3.032x/3T2014/info)
3. NPTEL MOOC Course on "Fundamentals of Material Processing - I" (https://onlinecourses.nptel.ac.in/noc17_mm09/preview)
4. NPTEL MOOC Course on "Fundamentals of Material Processing - I" (https://onlinecourses.nptel.ac.in/noc16_mm11/preview)
5. EdX Online Course on "Fundamentals of Manufacturing Processes" (https://www.edx.org/course/fundamentals-manufacturing-processes-mitx-2-008x)

Name of Institute: IITE
Name of Faculty: Mr. Monil Salot

Course code: MME0501
Course name: Steel Making
Pre-requisites: Mineral Processing, Introduction to Process Metallurgy, Iron Making
Credit points: 03
Offered Semester: 05

Course Coordinator
Full Name: Mr. Monil Salot
Department with sitting location: Metallurgical Engineering, Bhanwar Building, Lab-004 (GF)
Telephone: 9428600336
Email: monilsalot.mt@indusuni.ac.in
Consultation times: 3:45-4:20 PM

Course Lecturer
Full Name: Mr. Monil Salot
Department with sitting location: Metallurgical Engineering, Bhanwar Building, Lab-004 (GF)
Telephone: 9428600336
Email: monilsalot.mt@indusuni.ac.in
Consultation times: 3:45-4:20 PM

Students will be contacted throughout the Session via Mail with important information relating to this Course.

Course Objectives
By participating in and understanding all facets of this Course a student will:

1. To impart the overall idea of how Steel is produced the history of Steel making.

2. To know about various techniques of raw material preparation for charging in iron making furnace,

3. To design construction and operation of iron making furnace and reactions occurring in the furnace,

4. To Understand reaction mechanism inside the blast furnace and post treatment to make steel.

Course Outcomes (CO)

CO1: Ability to list and define terminologies and glossary involved with steel making. (BT-1)
CO2: To be able to explain and interpret various models and methods of steel making and casting. (BT-2)
CO3: To calculate mass balance equations and solve for materials needed for a particular batch of steel making. (BT-3)
CO4: To analyse processes involved in quality steel making for selecting the best process for a particular grade of steel. (BT-4)
CO5: To evaluate and grade the chemistry of steel with quality steel making . (BT-5)
CO6: To formulate synthetic slag and design meant to alter the chemistry in favour of desired grades. (BT-6).

Course Outline

Proposed course mainly deal with Reaction Mechanisms, Primary steel Making, Secondary and Quality Steel Making, Tools for Steel Making, and methods to produce clean castings and techniques for casting namely ingot and continuous.

Method of delivery

- Face to face lectures,
- Numerical and Simulations in Tutorials,
- Model Making
- Video Lectures When and as necessary

Study time

3 Lectures

CO-PO Mapping (PO: Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	1						1	2
CO2	2	2	3	2	2		1				1	2
CO3	3	2	1	2								2
CO4	2	2	3	2	1						1	2
CO5	2	1	3	2								1
CO6	2	1	3	2			2					1

1-Lightly Mapped 2- Moderately Mapped 3- Highly Mapped

Blooms Taxonomy and Knowledge retention

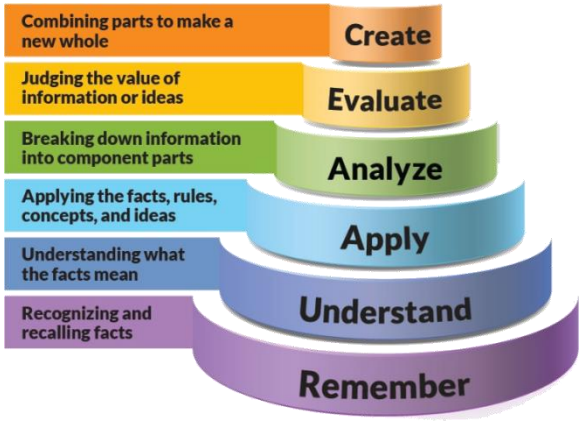


Figure 1: Blooms Taxonomy

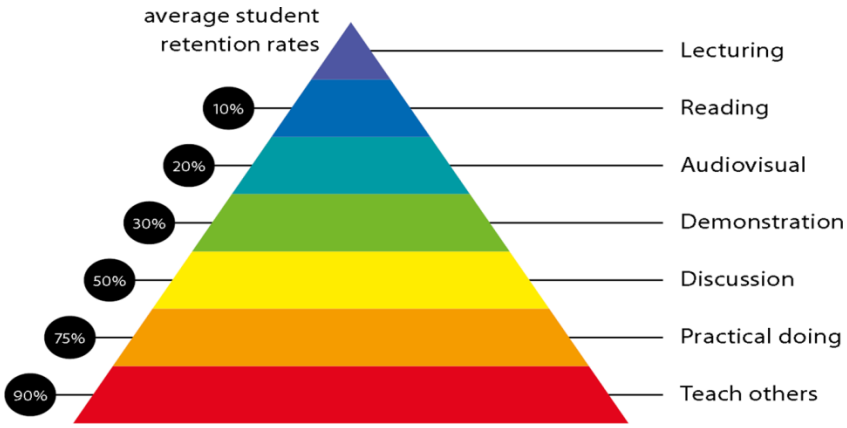


Figure 2: Knowledge retention

Graduate Qualities and Capabilities covered

(Qualities graduates harness crediting this Course)

General Graduate Qualities	Graduate Capabilities
Informed Have a sound knowledge of an area of study or profession and understand its current issues, locally and internationally. Know how to apply this knowledge. Understand how an area of study has developed and how it relates to other areas.	**1 Professional knowledge, grounding & awareness**
Independent learners Engage with new ideas and ways of thinking and critically analyze issues. Seek to extend knowledge through ongoing research, enquiry and reflection. Find and evaluate information, using a variety of sources and technologies.	**2 Information literacy, gathering & processing**

Acknowledge the work and ideas of others.	
Problem solvers Take on challenges and opportunities. Apply creative, logical and critical thinking skills to respond effectively. Make and implement decisions. Be flexible, thorough, innovative and aim for high standards.	**4 Problem solving skills**
Effective communicators Articulate ideas and convey them effectively using a range of media. Work collaboratively and engage with people in different settings. Recognize how culture can shape communication.	**5 Written communications** **6 Oral communication** **7 Teamwork**
Responsible Understand how decisions can affect others and make ethically informed choices. Appreciate and respect diversity. Act with integrity as part of local, national, global and professional communities.	**10 Sustainability, societal & environmental impact**

Practical work:

NA

Lecture/tutorial times

Lecture	Monday	09:00 – 10:00 AM	Room LH 3
Lecture	Tuesday	09:00 – 10:00 AM	Room LH 3
Lecture	Wednesday	11:10 – 12:10 PM	Room LH 3

Attendance Requirements

The University norms states that it is the responsibility of students to attend all lectures, tutorials, seminars and practical work as stipulated in the Course outline. Minimum attendance requirement as per university norms is compulsory for being eligible for mid and end semester examinations.

Details of referencing system to be used in written work

Reference Books
1. A. W. Cramb, “Making, Shaping and Treating of Steels”, Association of Iron and Steel Engineers, 11 th Edition, 1985, ISBN: 9780930767020.
2. R. G. Ward, “An Introduction to the Physical Chemistry of Iron and Steel Making”, Edward Arnold Ltd, 1 st Edition, 1962, ASIN: B0007IZZGY.
3. V. A. Kudrin, “Steel Making”, Mir Publisher, 1 st Edition, 1985, ASIN: B0007BN3H4.
Web Resources

Text books

Text Books
1. R. H. Tukary, “An Introduction to Modern Steel Making”, Khanna Publishers, 7 th Edition, 2000, ISBN: 9788174090263.
2. G. R. Bashforth, “The Manufacture of Iron and Steel: Vol I”, Chapman & Hall, 3 rd Edition,
1964, OCLC: 439659739.
3. G. R. Bashforth, “The Manufacture of Iron and Steel: Vol II”, Nabu Press, Primary Source Edition, 1964, ISBN: 9781295841929.

Additional Materials

1. NPTEL MOOC Course on “Steel Quality: Role of Secondary Refining & Continuous Casting”
(https://onlinecourses.nptel.ac.in/noc17_mm10/preview)

ASSESSMENT GUIDELINES

Your final course mark will be calculated from the following:

CIE 60 marks :(40 marks mid semester examination + 20 marks internal evaluation)
Breakup of 20 Marks: (05 marks as attendance bonus for all students having attendance > 80%) + (05 marks for presentation) +(10 marks for assignment or case studies)
ESE: 40 Marks of End Semester Examination

SUPPLEMENTARY ASSESSMENT

Students who receive an overall mark less than 40% in mid semester or end semester will be considered for supplementary assessment in the respective components (i.e mid semester or end semester) of semester concerned. Students must make themselves available during the supplementary examination period to take up the respective components (mid semester or end semester) and need to obtain the required minimum 40% marks to clear the concerned components For remedial and repeater remedial - CIE 60 marks (40 marks remedial mid semester examination + 20 marks for assignments or case studies, limited to minimum 04 assignments per course), and end semester repeater and remedial examination would be carried out centrally according to University Policy

Practical Work Report/Laboratory Report:

NA

Late Work

Late assignments will not be accepted without supporting documentation. Late submission of the reports will result in a deduction of -% of the maximum mark per calendar day

Format

All assignments must be presented in a neat, legible format with all information sources correctly referenced. **Assignment material handed in throughout the session that is not neat and legible will not be marked and will be returned to the student.**

Retention of Written Work

Written assessment work will be retained by the Course coordinator/lecturer for two weeks after marking to be collected by the students.

University and Faculty Policies

Students should make themselves aware of the University and/or Faculty Policies regarding plagiarism, special consideration, supplementary examinations and other educational issues and student matters.

Plagiarism - Plagiarism is not acceptable and may result in the imposition of severe penalties. Plagiarism is the use of another person's work, or idea, as if it is his or her own - if you have any doubts at all on what constitutes plagiarism, please consult your Course coordinator or lecturer. Plagiarism will be penalized severely.

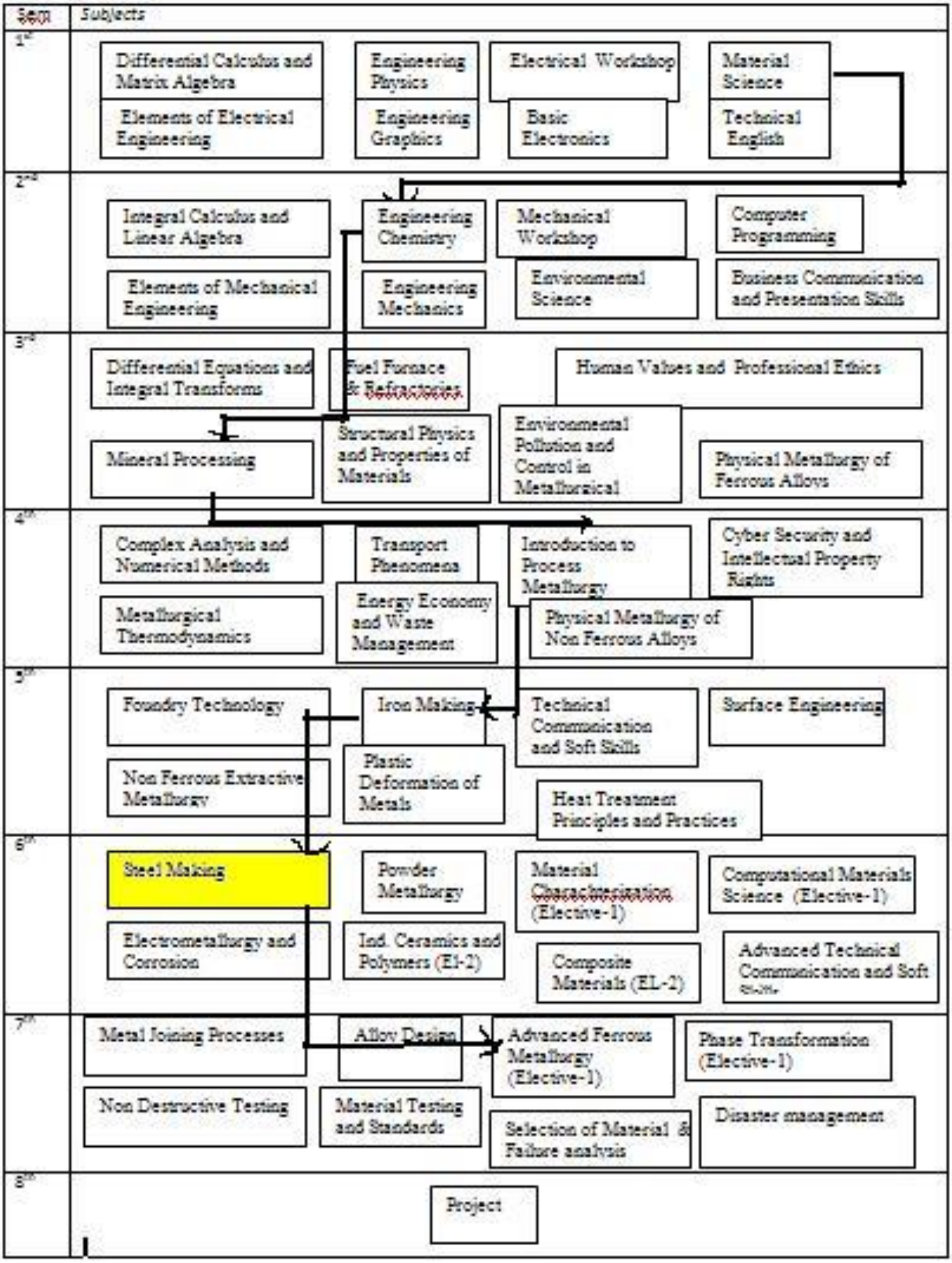
Do not copy the work of other students.
Do not share your work with other students (except where required for a group activity or assessment

Course schedule (subject to change)

	Week #	Topic & contents	CO Addressed	Teaching Learning Activity (TLA)
	Weeks 1	Reaction Mechanics	C01, C02	BB, PPT, OL
	Weeks 2	Reaction Mechanics and Slag Metal Understanding	C01, C02	BB, PPT, OL
	Week 3	Reaction of de-Carburisation	C01, C02	BB, PPT, OL
	Week 4	Reaction of Sulphur, Phospohorus	C01, C02	BB, PPT, OL
	Week 5	Reaction of Sulphur, Phospohorus	C01, C02	BB, PPT, OL
	Week 6	Primary Steel Making F/Cs	C01, C02	BB, PPT, OL
	Week 7	Primary Steel Making -BOF	C01, C02	BB, PPT, OL
	Week 8	Primary Steel Making -BOF	C01, C02	BB, PPT, OL
	Week 9	Primary Steel Making F/Cs	C01, C02	BB, PPT, OL
	Week 10	Primary Steel Making- Electric	C01, C02	BB, PPT, OL
	Week 11	Primary Steel Making- Electric	C01, C02	BB, PPT, OL
	Week 12	Quality and Secondary Steel Making	C01, C02	BB, PPT, OL
	Week 13	Quality and Secondary Steel Making	C01, C02	BB, PPT, OL
	Week 14	Quality and Secondary Steel Making	C01, C02	BB, PPT, OL

	Week 15	Ingot and Continous Casting	C01, C02	BB, PPT, OL
	Week 16	Defects in Casting	C01, C02	BB, PPT, OL

Program Map for Metallurgical Engineering Department (Mapped For Steel Making)


Sem
Subjects
1st
Differential Calculus and Matrix Algebra
Elements of Electrical Engineering
Engineering Physics
Engineering Graphics
Electrical Workshop
Basic Electronics
Material Science
Technical English
2nd
Integral Calculus and Linear Algebra
Elements of Mechanical Engineering
Engineering Chemistry
Engineering Mechanics
Mechanical Workshop
Environmental Science
Computer Programming
Business Communication and Presentation Skills
3rd
Differential Equations and Integral Transforms
Mineral Processing
Fuel Furnace & Refractories
Structural Physics and Properties of Materials
Human Values and Professional Ethics
Environmental Pollution and Control in Metallurgical
Physical Metallurgy of Ferrous Alloys
4th
Complex Analysis and Numerical Methods
Metallurgical Thermodynamics
Transport Phenomena
Energy Economy and Waste Management
Introduction to Process Metallurgy
Physical Metallurgy of Non Ferrous Alloys
Cyber Security and Intellectual Property Rights
5th
Foundry Technology
Non Ferrous Extractive Metallurgy
Iron Making
Plastic Deformation of Metals
Technical Communication and Soft Skills
Heat Treatment Principles and Practices
Surface Engineering
6th
Steel Making
Electrometallurgy and Corrosion
Powder Metallurgy
Ind. Ceramics and Polymers (El-2)
Material Characterization (Elective-1)
Composite Materials (EL-2)
Computational Materials Science (Elective-1)
Advanced Technical Communication and Soft
7th
Metal Joining Processes
Non Destructive Testing
Alloy Design
Material Testing and Standards
Advanced Ferrous Metallurgy (Elective-1)
Selection of Material & Failure analysis
Phase Transformation (Elective-1)
Disaster management
8th
Project

Subject: Steel Making								
Program: **B. Tech in Metallurgical Engineering**				Subject Code: **MME0501**			Semester: **V**	
Teaching Scheme (Hours per week)				**Examination Evaluation Scheme (Marks)**				
Lecture	**Tutorial**	**Practical**	**Credits**	**University Theory Examination**	**University Practical Examination**	**Continuous Internal Evaluation (CIE)- Theory**	**Continuous Internal Evaluation (CIE)- Practical**	**Total**
3	0	0	3	16/40	0	24/60	0	100

Course Objectives

1. To impart the overall idea of how Steel is produced the history of Steel making.
2. To know about various techniques of raw material preparation for charging in iron making furnace, construction and operation of iron making furnace and reactions occurring in the furnace, reaction mechanism inside the blast furnace and post treatment to make steel.

CONTENTS

UNIT-I

[10 hours]

General:

Old Steel Making practices. Modern equipment and practices. Integrated Steel Plants in India. Mini steel plants their advantages and limitations – present scenario.

Physical Chemistry of Steel Making:

Thermodynamic and Kinetics of Refining Reactions, Carbon, Phosphorus, Sulphur and Silicon Reactions. Refining Slag and its Properties. Importance and Mechanism of decarburization. Reaction at Slag Metal interface.

UNIT-II

[10 hours]

Basic Oxygen Steel Making:

BOF practice, Equipment, Operation and Process, slag Metal reactions in B.O.F. Raw material and flux practices. Kaldo, OBM, LD-AC, Rotor process, Top and Bottom blowing processes. **Oxygen Lance:**

Design, Construction and Operation. Top and Bottom Blown processes, Its advantages and disadvantages

Electric Steel Making:

Induction Furnace, Electric Arc Furnaces: Types and construction. Sequence of operations. Various additions at Different Stages, Slag Control. UHP Arc Furnaces. Arc Furnace practices for Carbon and Low Alloy Steels. Modern developments in ARC furnaces.

UNIT-III

[10 hours]

Quality Steel Making:

Introduction, Sources of Inclusions, Sulphur, Phosphorus, and Gases in Steels. Kinetics of Deoxidation of Molten Steel, Application of Ellingham Diagrams, Thermodynamics of Reaction During Degassing of Liquid Steel, Fluid Flow and Mixing in Ladle, Kinetics and Mass Transfer, Ladle Injection Metallurgy, Desulphurization & Dephosphorization.

Secondary Steel Making:

Metallurgical Principles in Secondary Steel Making and Secondary Steel Making Processes. Ladle Furnaces (L.F.), Vacuum Systems and Vacuum treatment of Steel. Removal of Gases from steel. LF-VD processes and AOD, VOD, VAD techniques, R-H degassers. Ladle Stirring and its Advantages. ESR Principle And Technology. Deoxidation – Theory and practice, Floatation's of deoxidation products, Modifications of Inclusions. Injection Metallurgy

UNIT-IV

[10 hours]

Inclusions in Steel:
Influence of Inclusions on Mechanical Properties of Steel, Inclusion, Identification and Cleanness Assessment, Origin of Non Metallic Inclusions, Inclusion Control Continuous Casting **(C.C.) and Ingot Casting:**
6 Hrs Ingot Casting: Types of Moulds, Advantages and Disadvantages. Ingot Defects and Remedies. Continuous casting: C.C. machines with its various units and types. C.C. of Blooms, Slabs and Thin slabs EM S of Moulds. Reoxidation prevention methods during Steel Casting. Advantage of C.C. Environmental issues related to Steel Making, Heat Transfer & Solidification Rate in Ingot Casting and Continuous Casting, Distinguishing Metallurgical Aspects of Continuous Casting of Steel.

Course Outcomes

1. To apply the knowledge of various types of routes of iron making to practical scenarios.
2. To innovate the existing ideas and ways of making Iron and developing the technology to make this process energy intensive and cost effective.

Text Books

1. R. H. Tupkary, "An Introduction to Modern Steel Making", Khanna Publishers, 7th Edition, 2000, ISBN: 9788174090263.
2. G. R. Bashforth, "The Manufacture of Iron and Steel: Vol I", Chapman & Hall, 3rd Edition, 1964, OCLC: 439659739.
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3. V. A. Kudrin, "Steel Making", Mir Publisher, 1st Edition, 1985, ASIN: B0007BN3H4.
4. A. K. Ghosh and A. Chatterjee, "Iron and Steel Technology".
5. E. T. Turkdogen, "Fundamentals of Steel Making".

Web Resources

1. NPTEL MOOC Course on "Steel Quality: Role of Secondary Refining & Continuous Casting" (https://onlinecourses.nptel.ac.in/noc17_mm10/preview)