GUJARAT TECHNOLOGICAL UNIVERSITY

METALLURGY ENGINEERING (21)
COMPUTATIONAL METALLURGY
SUBJECT CODE:2182113
B.E. 8th SEMESTER

Type of course: Engineering

Rationale: Decisions regarding Manufacturing development, optimization, or reorganization are driven by many factors and can be costly while the potential benefits are often hard to justify prior to implementation. Traditionally, decisions are made based upon intuition and past experience, sometimes with the support of spreadsheet tools. But these approaches can be risky and are far from modern management decision support. Simulation is one of the most powerful techniques currently being used to analyze manufacturing systems, evaluate the impact of changing various system parameters, and making the right probabilistic or multi-scenario informed decision.

Nowadays simulation modeling is widely used in metallurgical and manufacturing for various problems from intermediate process optimization. Even the implementation of well-understood metallurgical processes allows you to analyze not just the specific process but metallurgical system as a whole. Reducing the number of physical experiments and changes through the use of simulated experiments, for example, can be a huge advantage in personnel change and "process fatigue".

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Introduction, Basic principles and classification of modelling, General modelling of processes involving phase transformation e.g. solidification and heat treatment, deformation, extrusion, forging, joining, etc.	**08**	**08**
2	Physical modelling and Simulation - cold and hot models, Physical simulation, Similarity criteria, Transport and reaction simulation, Dimensional analysis, Case studies of simple models	**10**	**18**
3	Mathematical modelling, Advantages and limitations, Process control, Instrumentation and data acquisition systems.	**10**	**18**
4	Review of transport phenomena, differential equations and numerical methods, Concept of physical domain and computational domain, Assumptions and limitations in numerical solutions, Introduction to FEM.	**10**	**18**
5	Introduction to software packages like MATLAB, ANSYS etc, Useful websites and generic information about different products, Introduction to expert systems and artificial intelligence, Demonstration/practical training in some software packages, Use of computers for the construction of phase diagrams, phase transformations and thermo-chemical Calculations.	**10**	**18**

6	Modelling of Metallurgical processes: Solidification/heat transfer, Liquid metal treatment, Vacuum degassing, Continuous casting, Sand mold casting, Blast furnace, LD process, and Case studies from literature pertaining to modelling of metal forming and joining processes.	**12**	**20**
		Total 60	100

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**35**	**35**	**10**	**10**	**00**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Rate Phenomena in Process Metallurgy- J. Szekely and N.J. Themelis, Wiley Publication.
2. Computer Simulation of Flow and Heat Transfer - P.S. Ghosh Dastidar, Tata McGraw Hill.
3. Proc of the conference on Mathematical process models in Iron & Steel Making, (1975) London, The metals Society.
4. Proc. of Conf. on: Application of Mathematical and Physical models in the iron & steel industry (1982) , USA, ISS-AIME.
5. Proc. of Conf. on: Mathematical models for metals and materials (1987), Suffon Coldfield, UK, The Inst. of Metals.
6. Mathematical modeling of materials processing operation, Ed. J. Szekely et. al (1987), Warrandale, AIME.
7. Mechanical Metallurgy, G.E.Dieter, Tata McGraw Hill
8. Metal Casting, B Ravi,PHI
9. Introduction of Materials Modeling, Barber Z.H., 2005, Maney Publishing.
10. Modeling and Simulation of Mineral Processing Systems, King P.R., 2012, Society for Mining, Metallurgy & Exploration (SME).

Course Outcome:

After learning the course the students should be able to:

1. Understand the importance and necessity of simulation and modeling studies in metallurgical processes
2. Comprehend the data processing and process control
3. Improve theoretical background on simulation and modeling of metallurgical systems
4. Support theoretical background by hands-on application on a modeling software
5. Apply simulation and modeling software for innovative results
6. Create a model of a given metallurgical process by considering the related control parameters.

List of Experiments:

Based on Syllabus

Major Equipment:

Computer and Software packages

List of Open Source Software/learning website:

1. www.nptel.ac.in
2. www.autocast.co.in
3. http://www.ansys.com/Products/Academic/ANSYS-Student
4. https://in.mathworks.com/academia/students.html?requestedDomain=www.mathworks.com

5. http://www.nssmc.com/en/tech/report/nsc/pdf/n9415.pdf

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should be submitted to GTU.