GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Metallurgy
Subject Code: BE04021011
Subject Name: Introduction to Transport Phenomena in Metallurgy

w.e.f.Academic Year:	2024-25
Semester:	4
Category of the Course:	Professional Core Course

Prerequisite:	Nil
Rationale:	This course will introduce the concepts of fluid flow, heat transfer and mass transfer with behavior and processing of engineering materials as the focus. The course of Introduction to Transport Phenomena deals with various principles of fluid their flow and heat and mass transfer. As any metallurgical process involves fluids, heat and mass transfer this course aims to develop a basic understanding about the properties of fluids. Heat transfer is involved in metallurgical engineering processes like casting, welding, metal extraction by pyro-metallurgy or heat treatment of materials. The heat transfer modes namely conduction, convection and radiation are based on fundamental laws and its knowledge enhances the understanding of energy transfer in metallurgical processes. This will enable the students to apply basic principles of fluid mechanics and heat transfer to understand its role and to analyse and solve problems.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Understand fluid flows and related laws	10
CO-2	Pose a problem in transport phenomena as a balance equation	70
CO-3	Solve problems related to transport phenomena	20

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/CA (I)	PBL (I)	ESE (V)	
30	0	60	30	120	4	70	30	20	30	50	200

*** Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Definition and classification of fluids. Viscosity, Newtonian and non-Newtonian fluids. Viscous and non-viscous fluids. General features of fluid flow. Laminar and turbulent flow	**04**	**14**
2	Newton's law of viscosity, Balance of quantities using elemental volume approach, continuity equation, Navier-Stokes equation, laminar flow problems, exact solutions in rectangular coordinate systems, Flow through fluidized bed, flow rate measuring equipment	**10**	**30**
3	Fundamentals of heat conduction, convection, radiation and their combined Effect, steady and unsteady heat transfer, Fourier law of heat conduction. General equation of heat conduction in Cartesian co-ordinate	**05**	**18**
4	Convective heat transfer. Free and forced convection, Aspects of Radiative Heat Transfer. Reflection, absorption and transmission of radiation. Black body radiation. Planck's Law. Wein's distribution Law. Heat transfer between two bodies by radiation, exact analytical solutions, correlations for conjugate heat transfer	**05**	**20**
5	Diffusion and its application in solid state, convective mass transfer, unsteady diffusion in finite and infinite bodies, diffusion and chemical reactions	**06**	**18**
	Total	**30**	**100**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	**35**	**30**	**20**	**0**	**0**

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 Processes in Metallurgy, A. K. Mohanty
2. Principles of Extractive Metallurgy, A. Ghosh and H. S. Ray
3. Elements of Heat and Mass Transfer, Prof. R. C. Patel
4. Fundamentals of Heat and Mass Transfer, Inpropera and Dewitt

5. Rate Phenomena in Process Metallurgy, J. H. Szekely and N. J. Themelis
6. Fundamentals of Momentum, Heat and Mass Transfer, J. R. Welty, C. E. Wicks (Pub.-Wilson Wiley)
7. Chemical Engineering, J. M. Coulson and J. F. Richardson (Pub.- Mc. Hill ELBS)
8. Engineering in Process Metallurgy, RLL Guthrie (Pub.- Oxford).
9. Heat Transfer, Yunus Cenge

List of Experiments:

1. To study Pressure, measuring equipments, Pascal's Law and Bernoulli's Equation.
2. To study fluid and Fluid Properties.
3. To study different flow rate measuring equipment.
4. To measure fluid flow rate using venturi-meter.
5. To measure fluid flow rate using orifice meter.
6. To validate Bernoulli's theorem.
7. To measure Thermal Conductivity of Insulating Powder.
8. To determine Heat Transfer Coefficient for Given Composite Wall.
9. To determine Heat Transfer Coefficient by Natural Convection.
10. To determine Heat Transfer Coefficient in Force Convection.
11. To determine Stefan Boltzmann Constant.
12. To determine Emissivity Measurement.
13. Problems based on Fluid flow, Heat and Mass Transfer.
14. Report on lab visit/industrial visit/expert talk/online videos.
15. Poster/chart preparation on given topics based on curriculum.

List of Open Source Software/learning website:

I. http://nptel.iitm.ac.in/
II. http://ocw.mit.edu/
III. https://eerc03-iiith.vlabs.ac.in/
IV. https://fm-nitk.vlabs.ac.in/
V. https://me.iitp.ac.in/Virtual-Fluid-Laboratory/
VI. https://vmt-iitg.vlabs.ac.in/
VII. https://www.vlab.co.in/broad-area-chemical-engineering

- **Activities suggested under Problem Based Learning:**

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain

			observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numericals based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.
4.	Expert Lecture/session	Lecture = 2 hr Report = 1 hr Total = 03 h	Based on report submitted. Report should contain observation and learning.
5.	Self learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
8	Discussion on research paper based on relevant subject	5 research paper = 20 h	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 h Non- working = 8 h	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.

13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.

Note:

1. All the suggested activity should be related to the subject.

2. The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.

3. Rubrics for the evaluation can be prepared by the faculty.

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