GUJARAT TECHNOLOGICAL UNIVERSITY

BIO-TECHNOLOGY(04)

PRINCIPLES OF PROCESS ENGINEERING-I

SUBJECT CODE: 2140403

B.E. 4th SEMESTER

Type of course: Bio-Technology Engineering

Prerequisite: Basic concepts of Engineering Mathematics and Physics.

Rationale: Bio-Technology Engineering has to do with industrial processes in which raw materials are processed and separated into useful products. The behaviour of fluids is an important to process engineering and constitutes one of the foundations for the study of the unit operations. This subjects also provides the conceptual idea of the heat transfer, which is one of the important transfer process in engineering field.

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		
3	0	3	6	70	20	10	20	10	20	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
	Part [A] Process Heat Transfer		
1.	**Modes of Heat Transfer:** Introduction to three modes of heat transfer: Conduction, Convection & Radiation, General laws of heat transfer, etc.	04	60%
2.	**Conduction:** Fourier's law of conduction, Application of Fourier's law for plane wall, composite wall, cylinder, sphere, etc., Heat transfer in case of simultaneous conduction &convection for plane wall & cylinder, unsteady state heat conduction, Concept of critical thickness of insulation, etc.	07	
3.	**Convection:** Natural convection & forced convection, Empirical equation for individual coefficients, significance of Prandtl No, Grashoff no, Nusselt no, peclet no, etc.	06	
4.	**Radiation:** Wave and Quantum theory of radiation heat transfer, Black body,Graybody,Transmissivity,Absorrtivity,Reflectivity,Emissivity,etc.,Derivation of Stefan Boltsmanns law, Wiens law, Kirchoff's law, etc.	07	
5.	**Heat Exchangers :** Types of heat exchanger's, LMTD, Heat transfer area requirement, Overall heat transfer coefficient.	04	
	Part [B] Fluid Flow Operations		
6.	**Introduction to Engineering Calculation:** Units & Dimensions, Dimensional Analysis, Transport Properties, Fluid dynamics, Fluid Statics, Reynolds's number & its significance, Boundary layer formation & separation, etc.	08	40%
7.	**Flow of Incompressible Fluid:** Flow between two plates and pipes, Mass velocity, Average velocity, potential flow, Streamlines etc. Equation of Continuity, Bernoulli's equation	05	

	and its applications, etc.		
8.	**Flow Passed Bodies:** Drag Force, Fluidization, etc.	05	
9.	**Transportation of Fluids:** Pumps, Valves, Metering devices, etc.	05	
10.	**Momentum Transfer in Biotechnology:** Rheological Behaviour of fermentation broth, two-parameter, three parameter models, etc.	03	

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
R Level	U Level	A Level	N Level	E Level
18	24	23	5	0

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate 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. 'Unit Operations of Chemical Engineering', McCabe W L, Smith J C, Harriott P, 7th Ed. McGraw Hill, 2005.
2. 'Chemical Engineering Vol. I', Coulson & Richardson's, 6th Editions.
3. 'Fluid Dynamics and Heat Transfer', James G. Knudson and Donald L. Katz., Mc Graw Hill Publication.
4. 'Bioprocess Engineering Principles', Paulin M Doran, 2nd Edition, Elsevier science and technology publication.
5. 'Heat Transfer', Donald Q Kern, McGraw Hill

Course Outcome: After learning the course the students should be able:

1. To build basic knowledge of the heat transfer and Fluid flow operation.
2. To review the practical importance and relevance of energy transfer and its conservation in chemical industry.
3. To utilize the technological methods related to heat transfer and fluid flow operations in process plant.
4. To study a detailed overview of heat transfer equipment and fluid flow operations problems associated at preliminary stage of design.
5. To build a bridge between theoretical and practical concept used in industry.

List of Experiments and Open Ended Projects:

Minimum **5** practicals to be performed and remaining time should be allotted to open-ended projects / study reports / latest outcomes in technology study:-

1. In the beginning of the academic term, faculties will have to allot their students at least one Open-ended Project / Study Report / Latest outcome in technology.
2. Literature survey including patents and research papers of fundamental process

- Design based small project **or**
- Study report based on latest scientific development **or**
- Technology study report/ modeling/ simulation/collection report **or**
- Computer based simulation/ web based application/ analysis presentations of basic concept field

which may help them in chemical engineering.
3. These can be done in a group containing maximum **three** students in each.
4. Faculties should cultivate problem based project to enhance the basic mental and technical level of students.
5. Evaluation should be done on **approach of the student on his/her efforts** (not on completion) to study the design module of given task.
6. In the semester student should perform **minimum** 5 set of experiments and complete **one small open ended dedicated project** based on engineering applications. This project along with any performed experiment should be **EVALUATED BY EXTERNAL EXAMINER.**

List of Experiments (any five)

1. To study and verify Bernoulli's Theorem
2. To calibrate an Venturi meter and obtain it's coefficient of discharge
3. To calibrate an Orifice meter and obtain it's coefficient of discharge
4. To study a Rotameter and obtain it's coefficient of discharge
5. To study Notched Weirs Apparatus and obtain its discharge coefficient.
6. Study of Pressure measurement devices
7. Friction Vs. Re losses in Pipe Friction using water
8. To study Reynolds's Experiment Apparatus
9. Study of Centrifugal pump testing
10. Study of Shell & Tube heat exchangers
11. To study Finned tube heat exchanger
12. To study Plate type heat exchanger
13. To study Thermal conductivity metal rod
14. To study Emissivity measurement Apparatus

Design based Problems (DP)/Open Ended Problem:
Students are free to select any area of fluid flow technology and heat transfer based on Bio- technology Engineering applications to define project. Some suggested projects are listed below:

- Carry out projects on Notch and Weirs
- Designing of various fluid flow experiments set up.
- Projects on fluid moving machinery, etc.
- Carry out projects on heat exchange equipments

Major Equipment:

Venturimeter, Orifice meter, Rotameter, Various pumps, Notches, Pipes and Valves, Shell & tube heat exchanger, Finned tube heat exchanger, Plate type heat exchanger, Thermal conductivity metal rod, Emissivity measurement apparatus.

List of Open Source Software/learning website:

- Literature available in laboratory manual of Principle of Process Engineering-I
- NPTL
- MIT Open course lecture on Fluid Dynamics & Heat Transfer

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 of Process Heat Transfer and fluid flow operation is 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 sent to GTU.