

COURSE DELIVERY PLAN - THEORY

Page 1 of 6

	Department of Biotechnology		LP: BT18403 Rev. No: 02
			Rev. 110. 02
B.E/B.Tech/M.E/M.Tech : B.	. <u>Tech</u> (Biotechnology)	Regulation: 2018	Date: 11.01.23
PG Specialisation : -			
Sub. Code / Sub. Name : BT1	18403 – Thermodynamics for Biotechnol	logists	
Unit : I			

Unit Syllabus: THERMODYNAMIC LAW AND PROPERTIES OF FLUIDS

9 hrs

First Law of Thermodynamics, a generalized balance equation and conserved quantities, Volumetric properties of fluids exhibiting non ideal behavior; residual properties; estimation of thermodynamic properties using equations of state; calculations involving actual property exchanges; Maxwell's relations and applications.

Objective: This course aims to give strong foundation on first law of thermodynamics, Maxwell relations, volumetric properties and its applications.

Session No *	Topics to be covered	Ref	Teaching Aids
1	Introduction to Thermodynamics, Classification of Thermodynamic properties.	1 – Ch.1; Pg. 1-15	LCD
2	Volumetric properties of pure fluids-PVT behavior, Virial equation and its application, various correlations, Simple problems.	1 – Ch.1; Pg. 64-98	LCD
3	Residual properties-Gibbs energy, Thermodynamic diagrams.	1 – Ch.6; Pg. 199- 219 2- Ch.6; Pg. 257-262 3- Ch.6; Pg. 229-239	LCD
4	Clapeyron equation, Entropy heat capacity equations.	2 – Ch.6; Pg.213-220	LCD
5	Effect of temperature, pressure and volume on U, H and S, CP-CV relationship, Problems.	2 – Ch.6; Pg. 220- 232	LCD
6	Joule-Thomson Coefficient, Gibbs-Helmholtz Equation.	2 – Ch.6; Pg. 233- 235	LCD
7	Problems involving actual property exchanges.	2 – Ch.6; Pg. 244- 256	BB
8	Maxwell's relations and applications, Additional problems in Unit 1	2 – Ch.6; Pg.211-213	BB
9	Review of unit 1 and giving assignment for students from Unit 1 problems.	-	BB
Content	beyond syllabus covered (if any): -NIL-		



COURSE DELIVERY PLAN - THEORY

Page 2 of 6

Sub. Code / Sub. Name: BT18403 - Thermodynamics for Biotechnologists

Unit : II

Unit Syllabus : SOLUTION THERMODYNAMICS

9 hrs

Partial molar properties; concepts of chemical potential and fugacity; ideal and non-ideal solutions; concepts and applications of excess properties of mixtures; activity coefficient; composition models; Gibbs Duhem equation.

Objective: This course aims to gain knowledge in solution thermodynamics and its concepts of chemical potential, fugacity, activity coefficient and Gibbs Duhem equation.

Session No *	Topics to be covered	Ref	Teaching Aids
1	Partial molar properties-physical meaning of partial molar properties, determination of partial molar properties.	1 – Ch.11; Pg. 381-390 2 – Ch. 7; Pg. 273-283 3 – Ch. 9; Pg. 333 – 342	LCD
2	Chemical potential, Effect of temperature and pressure on Chemical potential.	1- Ch.11; Pg. 380-381 2 - Ch.7; Pg. 284-287 3- Ch. 9; Pg. 343-346	LCD
3	Fugacity and Fugacity coefficient for pure species and species in solution, Generalized correlations for Fugacity coefficient, Problems involving Fugacity and Fugacity	1-Ch.11; Pg. 394 - 410 2- Ch.7; Pg. 288-292 3 – Ch.9; Pg. 353 – 359	LCD/BB
4	Ideal and non-ideal solutions, Raoult's law, Henry's law, Problems.	1-Ch.10; Pg. 350-362 2-Ch.7; Pg.292-295	LCD/BB
5	Concepts and applications of excess properties of mixtures	1-Ch.11; Pg. 413-429 2-Ch.7; Pg. 317-319 3-Ch.9; 366 – 370	LCD
6	Activity, Activity coefficient, Effect of temperature and pressure on Activity coefficient, Problems.	2- Ch.7; Pg. 296-301 3-Ch.9; Pg. 347 – 349	LCD
7	Gibbs Duhem Equation and problems related to it.	2-Ch.7; Pg. 302-307 3-Ch.9; Pg. 349-352	LCD/BB
8	Additional problems in unit 2	1-Ch.12; Pg.449-482 2-Ch.7; Pg. 307-316	BB
9	Review of unit 2 and giving assignment for students from Unit 2 problems.	-	BB
Content b	eyond syllabus covered (if any): - NIL-	<u>.</u>	



COURSE DELIVERY PLAN - THEORY

Page 3 of 6

Sub. Code / Sub. Name: BT18403 - Thermodynamics for Biotechnologists

Unit : III

Unit Syllabus : PHASE EQUILIBRIA

9 hrs

Criteria for phase equilibria; v-l-e calculations for binary and multi component systems; liquid-liquid equilibria and solid-solid equilibria.

Session No *	Topics to be covered	Ref	Teaching Aids
1	Criteria of Phase equilibria-Constant U and V, Constant T and V, Constant P and T.	2 – Ch.8; Pg. 330 -332 3-Ch.10; Pg. 383 – 386	LCD
2	Criterion of stability, Vapor-liquid equilibria, Phase diagram for binary solutions, Problems.	2- Ch.8; Pg.332-340 3-Ch.10; Pg. 387- 390	LCD/BB
3	Vapor-liquid equilibria for multicomponent system, Problems	2-Ch.8; Pg. 386-394 3-Ch.10; Pg. 391 – 395	LCD/BB
4	Binary liquid-liquid equilibria, Diagrams	2-Ch.8; Pg.408- 410 3-Ch.11; Pg.449 – 453	LCD
5	Multicomponent liquid-liquid equilibria, Diagrams	2-Ch.8; Pg.408-410	LCD
6	Liquid-Liquid equilibria problems	2-Ch.8; Pg.408- 410 3-Ch.11; Pg.449 – 453	BB
7	Solid- Solid equilibria	1-Ch.1; Pg.526-535 3- Ch.14; Pg. 597-605	LCD
8	Additional problems in unit 3	1-Ch.10; Pg. 338-362 2-Ch.8; Pg. 386-397	BB
9	Review of unit 3 and giving assignment for students from Unit 3 problems.	-	BB
Content	beyond syllabus covered (if any): -NIL-		

Objective: This course provides information on VLE and Liquid-liquid phase equilibria



COURSE DELIVERY PLAN - THEORY

Page 4 of 6

Sub. Code / Sub. Name: BT18403 - Thermodynamics for Biotechnologists

Unit : IV

Unit Syllabus : CHEMICAL REACTION EQUILIBRIA

9 hrs

Equilibrium criteria for homogeneous chemical reactions; evaluation of equilibrium constant; effect of temperature and pressure on equilibrium constant; calculation of equilibrium conversion and yields for single and multiple reactions.

Objective: This course helps to gain knowledge in chemical reaction equilibrium concepts like equilibrium constant, equilibrium conversion for single, multiple, homogeneous and heterogeneous reactions

Session No *	Topics to be covered	Ref	Teaching Aids
1	Equilibrium criteria for homogeneous chemical reactions and its applications, Standard Gibbs energy.	1-Ch.13; Pg. 484-488 2- Ch. 9; Pg. 425- 430 3 - Ch.12; Pg. 470 - 474	LCD
2	Equilibrium constant, effect of temperature and pressure on equilibrium constant, Problems.	1-Ch.13; Pg. 489- 492 2-Ch.9; Pg. 436-449) 3-Ch.12; Pg. 475-476	LCD/BB
3	Evaluation of equilibrium constant, Problems.	1-Ch.13; Pg. 496- 498 3-Ch.12; Pg. 475-476	LCD/BB
4	Calculation of equilibrium conversion and yields for single reaction and related problems.	1-Ch.13; Pg. 502-513	LCD/BB
5	Calculation of equilibrium conversion and yields for multiple reaction and related problems.	1-Ch.13; Pg. 502-528	LCD/BB
6	Other factors affecting equilibrium conversion like inert materials, excess of reactants, products etc.,	2-Ch.9; Pg. 450-458 3-Ch.12; Pg. 493- 496	LCD/BB
7	Additional problems in Unit 4	1-Ch.13; Pg. 483-528	BB
8	Additional problems in Unit 4	1-Ch.13; Pg. 483-528	BB
9	Review of unit 4 and giving assignment for students from Unit 4 problems.	-	BB
Content	beyond syllabus covered (if any): -NIL-		



COURSE DELIVERY PLAN - THEORY

Page 5 of 6

9 hrs

Sub. Code / Sub. Name: BT18403 - Thermodynamics for Biotechnologists

Unit : V

Unit Syllabus : THERMODYNAMIC DESCRIPTION OF MICROBIAL GROWTH AND PRODUCT

FORMATION

Thermodynamics of microbial growth stoichiometry thermodynamics of maintenance, Calculation of the Operational Stoichiometry of a growth process at different growth rates, including Heat using the Herbert-Pirt relation for Electron donor, thermodynamics and stoichiometry of product formation.

Objective: This course provides knowledge in thermodynamic description of microbial growth and product formation models like Herbert-Pirt model and Compromise model

Session No *	Topics to be covered	Ref	Teaching Aids
1	Thermodynamics of microbial growth, Cellular respiration	Internet notes	LCD
2	Stoichiometry thermodynamics of maintenance	Internet notes	LCD
3	Non-growth components and models for microbial maintenance	Internet notes	LCD
4	Herbert Model & Pirt Model	Internet notes	LCD
5	Compromise Model	Internet notes	LCD
6	Relationship between three models	Internet notes	LCD
7	Overall maintenance coefficient and Multi-Parameter Sensitivity analysis	Internet notes	LCD
8	Implications of microbial ecology modeling	Internet notes	BB
9	Review of unit 5 and giving assignment for students from Unit 5 problems.	-	BB
Content b	beyond syllabus covered (if any): Cellular respiration		



COURSE DELIVERY PLAN - THEORY

Page 6 of 6

Sub Code / Sub Name: BT18403 - Thermodynamics for Biotechnologists

REFERENCES:

TEXT BOOK (TB):

1. Smith J.M., Van Ness H.C., Abbot M.M. Chemical Engineering Thermodynamics. 7th Edition. McGraw-Hill, 2010.

2. Narayanan K.V. A Text Book of Chemical Engineering Thermodynamics. Eastern Economy Ed, PHI, 2015.

3. Gopinath Halder. Introduction to Chemical Engineering Thermodynamics, PHI, 2009.

4. Christiana D.Smolke. The Metabolic pathway engineering handbook fundamentals, CRC Press Taylor & Francis Group, 2010.

5. Urs von Stockar, Thomas Maskow, Jingsong Liu, Ian W.Marison, Rodrigo Patino. Thermodynamics of microbial growth and metabolism: an analysis of the current situation (2006) Journal of Biotechnology, 121, 517-533.

6. Gangsheng Wang, Wilfred M.Pos. A theoretical reassessment of microbial maintenance and implications for microbial ecology modeling (2012) FEMS Microbiol Ecol, 81, 610-617.

	Prepared by	Approved by
Signature	T:K: Bowees	14773
Name	Dr. P.K. PRAVEEN KUMAR	Dr. E. NAKKEERAN
Designation	PROFESSOR	PROFESSOR & HOD
Date	11.01.2023	11.01.2023