SRI VENKATESWARA COLLEGE OF ENGINEERING

COURSE DELIVERY PLAN - THEORY

Department of **Biotechnology**	LP: BY22101 Rev. No: 00 Date: 09.11.2022
B.E/B.Tech/M.E/**M.Tech** : **Biotechnology** Regulation: **2022** PG Specialisation : **NA** Sub. Code / Sub. Name : **BY22101 / Advanced Bioprocess Technology** Unit : **I**	

Unit Syllabus: **STOICHIOMETRY AND ENERGETICS (9 + 3 h)**

Stoichiometry of growth and product formation - Elemental balances, Electron Balances, Degrees of reduction, Yield coefficients; Energy Balances-Thermodynamics of Microbial growth, Heat of Reaction, Energy balance equation for cell culture

Objective: To provide knowledge on material and energy balances in microbial systems.

Session No *	Topics to be covered	Ref	Teaching Aids
1	Stoichiometry of growth and product formation	T1(13-88); T2(10-15)	BB & PPT
2	Elemental balances and Problems	T1(67-72); T2(51-68); T3(29-37)	BB & PPT
3	Electron Balances and Problems	T1(67-72); T2(51-68); T3(29-37)	BB & PPT
4	Degrees of reduction and Problems	T1(96-97); T3(67-79)	BB & PPT
5	Yield coefficients and Problems	T1(139-154);	BB & PPT
6	Energy Balances and Problems	T2(100-102)	BB & PPT
7	Energy balance equation for cell culture	T1(73-74); T2(20-22)	BB & PPT
8	Heat of Reaction and Problems	T2 (20-29);	BB & PPT
9	Thermodynamics of Microbial growth	T1(134-154)	BB & PPT
10	Problems on Materials and Energy Balances	R1(139-154);	BB & PPT
11	Problems on Materials and Energy Balances	R2(100-102)	BB & PPT
12	Problems on Materials and Energy Balances	T1(129-154);	BB & PPT
Content beyond syllabus covered (if any): NA			

* Session duration: 50 minutes

Sub. Code / Sub. Name: **BY22101 / Advanced Bioprocess Technology**

Unit : **II**

Unit Syllabus : **MICROBIAL KINETICS AND MODELS (9 + 3 h)**

Michaelis-menton kinetics; Cell growth kinetics– Monod model, Models with growth inhibitors, Logistic equation; Structured models; Kinetics of product formation; Substrate uptake kinetics; Thermal death kinetics; Determination of kinetic parameters.

Objective: To get knowledge on microbial kinetics and different structured and unstructured models.

Session No *	Topics to be covered	Ref	Teaching Aids
13	Michaelis-menton kinetics	T1(83-88); T2(140-143)	BB & PPT
14	Cell growth kinetics: Derivation	T1(67-72); T2(151-168) T3(29-37, 309-312)	BB & PPT
15	Monod model and Problems	T1(91-93); R1(296-308)	BB & PPT
16	Models with growth inhibitors: Derivation	T1(96-97); T3(67-79)	BB & PPT
17	Problems on Models with growth inhibitors	T1(99-100); T3(67-79)	BB & PPT
18	Problems on Logistic Equation	T1(136-140); T2(200-202)	BB & PPT
19	Structured models	R1(124-136, 152-169)	BB & PPT
20	Kinetics of product formation	T1(170-181)	BB & PPT
21	Substrate uptake kinetics	T3(167-178)	BB & PPT
22	Thermal death kinetics	T1(99-100); T3(67-79)	BB & PPT
23	Determination of kinetic parameter: Problems	R1(136-140); R3(200-202)	BB & PPT
24	Determination of kinetic parameter: Problems	T1(99-100); T3(67-79)	BB & PPT
Content beyond syllabus covered (if any): NA			

* Session duration: 50 mins

Sub. Code / Sub. Name: **BY22101 / Advanced Bioprocess Technology**

Unit : **III**

Unit Syllabus: **IDEAL BIOREACTOR OPERATION (9 + 3 h)**

Batch operation of a mixed reactor, Fed-batch operation of a mixed reactor, Continuous operation of a mixed reactor, Chemostat with immobilized cells, Chemostat cascade, Chemostat with cell recycle, Continuous operation of a plug flow reactor.

Objective: To familiarize about different modes of operating ideal bioreactors.

Session No *	Topics to be covered	Ref	Teaching Aids
25	Modes of Operation of Bioreactors	T1(257-260); T2(767-769);	BB & PPT
26	Batch operation of a mixed reactor: Derivation	T2(769-770);	BB & PPT
27	Batch operation of a mixed reactor: Problems	T1(260-266); T2(771-776);	BB & PPT
28	Fed-batch operation of a mixed reactor: Derivation	T1(267-273); T2(773-774, 779-781);	BB & PPT
29	Fed-batch operation of a mixed reactor: Problems	T1(283-316); T2(808-809)	BB & PPT
30	Chemostat with immobilized cells: Derivation	T1(283-316);T3(852-853)	BB & PPT
31	Chemostat with immobilized cells: Problems	T1(305-309); T3(874-877);	BB & PPT
32	Chemostat Cascade	T3(321-338); T3(848-852)	BB & PPT
33	Chemostat with cell recycle: Derivation	T3(329-332);	BB & PPT
34	Chemostat with cell recycle: Problems	T3(260-266); T4(771-776);	BB & PPT
35	Continuous operation of a plug flow reactor: Derivation	T1(267-273); T2(773-774, 779-781);	BB & PPT
36	Continuous operation of a plug flow reactor: Problems	T1(260-266); T2(771-776);	BB & PPT
Content beyond syllabus covered (if any): Combined first and second-generation technology.			

* Session duration: 50 mins

Sub. Code / Sub. Name: **BY22101 / Advanced Bioprocess Technology**

Unit : **IV**

Unit Syllabus : **BIOREACTOR DESIGN AND CONSTRUCTION (9 + 3 h)**

Practical considerations for Bioreactor construction; Bioreactor configurations; Agitator design - Power requirements for mixing, Estimation of mixing time; Oxygen transfer in Fermenters - Measurement of kLa; Heat transfer equipment - Design and Applications.

Objective: To design bioreactors with efficient heat and mass transfer provisions.

Session No *	Topics to be covered	Ref	Teaching Aids
37	Practical considerations for Bioreactor construction	T1(369-374);T3(154-170)	BB & PPT
38	Stirred Tank Reactor	T1(376-406) T2(191-213)	BB & PPT
39	Air driven Reactors: Fluidized bed reactors	T1(376-406) T4(191-213)	BB & PPT
40	Air driven Reactors: Bubble column reactors	T2 (224-238)	BB & PPT
41	Air driven Reactors: Air lift reactors	T2 (238-256)	BB & PPT
42	Packed bed reactors	T1(198-213)	BB & PPT
43	Power requirements for mixing: Problems	T1(407-416)	BB & PPT
44	Estimation of mixing time: Problems	T1(577-586)	BB & PPT
45	Oxygen transfer in Fermenters	T1(566-576) T2(512-522)	BB & PPT
46	Measurement of kLa: Problems	T1(376-406) T2(191-213)	BB & PPT
47	Design and Applications of heat transfer equipments	T1(376-406) T21(191-213)	BB & PPT
48	Problems on design of heat transfer equipments	T1(376-406) T3(191-213)	BB & PPT

Content beyond syllabus covered (if any): Dark Fermentation for Biohydrogen production

* Session duration: 50 mins

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Unit : **V**

Unit Syllabus : **ADVANCED BIOREACTORS AND BIOPRODUCTS (9 + 3 h)**

Bioreactor considerations for immobilized cell systems, Plant cell cultures, Animal cell cultures, Organized tissues; Case studies on production of Monoclonal antibodies, Recombinant insulin, Green fuels and chemicals; Case studies on medium optimization.

Objective: To learn about advancement in bioreactors for non-conventional biological systems.

Session No *	Topics to be covered	Ref	Teaching Aids
49	Introduction to Advanced bioprocesses	T4(447-451)	BB & PPT
50	Bioreactor considerations for immobilized cell systems	T4(451-470)	BB & PPT
51	Bioreactor considerations for Plant cell cultures	T4(500-503)	BB & PPT
52	Bioreactor considerations for Animal cell cultures	T4(503-510)	BB & PPT
53	Bioreactor considerations for Organized tissues	T4(523-535); T5(614-618)	BB & PPT
54	Monoclonal antibodies	T1(540-546)	BB & PPT
55	Production of Monoclonal antibodies	R4(500-503); R5(618-619);	BB & PPT
56	Recombinant insulin	R4(536-537, 551-562)	BB & PPT
57	Production of recombinant insulin	R3(512-534)	BB & PPT
58	Green fuels and chemicals	T4(523-535); T5(614-618)	BB & PPT
59	Production of Green fuels and chemicals	T3(523-535); T2(614-618)	BB & PPT
60	Statistical Medium optimization.	T1(523-535); T2(614-618)	BB & PPT
Content beyond syllabus covered (if any): NA			

* Session duration: 50 mins

Sub Code / Sub Name: **BY22101 / Advanced Bioprocess Technology**

TEXT BOOKS

1. Pauline D., Bioprocess Engineering Principles, Elsevier, 2nd Edition, 2012.
2. Shuler, M.L., Kargi F., Bioprocess Engineering, Prentice Hall, 2nd Edition,2002
3. Bailey, J.E. and Ollis, D.F. Biochemical Engineering Fundamentals", McGraw Hill, 2nd Edition, 2017.
4. Stanbury, P.F., Stephen J.H., Whitaker A., Principles of Fermentation Technology, Science & Technology Books, 2nd Edition, 2009
5. Blanch H.W., Clark D. S., Biochemical Engineering, Marcel Dekker, Inc. 2nd Edition, 1997.

REFERENCE BOOKS

1. James M. Lee, Biochemical Engineering, Prentice Hall, 1992.
2. Ghasem D.Najafpour, Biochemical Engineering and Biotechnology, Elsevier, 2007.
3. Irving J.Dunn, Elmar Heinzle, John Ingham, Jiri E. Prenosil, Biological Reaction Engineering, Wiley, 2003.
4. Jens Nielson, John Villadsen, Gunnar Liden, Bioreaction Engineering principles, Kluwer Academic/Plenum Publishers, 2003.
5. Michael C.Flickinger, Stephen W.Drew, Encyclopedia of Bioprocess Technology: Fermentation, Biocatalysis and Bioseparation Volumes 1-5, John Wiley & Sons, Inc., 1999.

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Date	09-11-2022	09-11-2022
Remarks *: Yes		
Remarks *: Yes		

* If the same lesson plan is followed in the subsequent semester/year it should be mentioned and signed by the Faculty and the HOD