Lovely Professional University, Punjab

FORMAT FOR INSTRUCTION PLAN [for Courses with Lectures, Tutorials (if applicable) and Labs]

Term: 20910

Course No.BTY 304 Course Title: Bioproccess engeneering II L: 3 T: 1 P: 2 Cr: 5

Textbook: 1. Pauline M. Doran; Bioprocess Engineering Principles, Elsevier Science and technology books,1st edition, 2007.

Other specific books: 2. Stanbury P F Whitaker, A and Hall S.J, Principles of Fermentation Technology 2nd ed, Aditya Book Pvt Ltd, 2001
3. Doran P M; Bioprocess engineering principles 2nd edition.

Other readings:

S.No.	Journal articles as compulsory readings (Specific articles, *Complete reference*)
4	Paula, Susan G. Karp, Julio C. Carvahlo; Production of bioethanol from soybean; Bioresource Technology; Vol. 99; Pages 8156-8163
5	Burkhard Horstkotte, Carolina, Victor Cerda; Modifications of batch reactor for culture of *Pichia pastoris* Biochemical Engineering journal ; Vol. 42,Issue 1, page 77-83.

Relevant websites:

S.No.	Web address (*Exact page address*)	Salient Features
6.	www.efluids.com/fluids/laminar/turbulent flow	Various patterns of fluid flow during bioreactor processes
7.	www.che.com/processing and handling/reaction _engineering	Various aspects related to application of chemical engineering in bioprocess
8.	http://www.ncbi.nlm.nih.gov/sites/entrez	Research papers related to new scientific discoveries on bioprocess

Note : Serial no. of text book , other specific books , other readings and websites should be in continuity and can go to any number, as illustrated in the format.

Detailed Plan for Lectures

Week No.	Lecture No.	Topic	Chapters/ Sections of Textbook/ other reference[1]	Homework to be assigned to students [3]	Pedagogical tool Demonstration/ case study/ images/ animations etc.**planned**[4]	Pedagogical tool Demonstration/ case study/ images/ animations etc.**actually used**	Date Delivered[2] (Mention **Regular (R) / Make Up (M)** class)
Part 1 (one fourth of total number of lectures)							
1	1	Sterilization air and media sterilizations	13/13.6				
1	2	Design of batch sterilization process	13/13.6/13.6.2		www.efluids.com/fluid/lamuinar/turbulent		
1	3	Del factor, sterilization cycle	13/13.6/13.6.2	DOA-H1			
2	4	Continous sterilization process	13/13.6/13.6.2				
2	5	sterilization of fermenters.	13/13.6/13.6.3, 13.6.4	TPA			
2	6	Design of a fermenter: baffles, spargers, impellers	13/13.1,13.2	DOS-H1			
3	7	Design of a fermenter: Various other aspects related to designing	13/13.1,13.2		www.che.com/processing and handling/reaction _engineering		
3	8	Fermenter for microbial processes	13/13.2		http://www.youtube.com/watch?v=A		

					3jlKKeCcKA (Fermenter)		
3	9	Fermenters for animal cell & plant cell culture	13/13.2	DOT-1	http://www.youtube.com/watch?v=BbnpkB-dVVA (Animal cell Bioreactor)		
Part 2 (another one fourth of total number of lectures)							
4	10	Aseptic operation of fermenter	13/13.6	DOA-2			
4	11	Control and measurement equipments of fermenter	13/13.4.1				
4	12	Control and measurement equipments of fermenter	13/13.4.1				
5	13	pH and D.O. probes	9/9.7	DOS-2			
5	14	Impeller and spargers	7/7.9,7.9.1				
5	15	Batch Reactor operation	13/13.5,13.5.3				
6	16	Fed batch operations	13/13.5,13.5.3		http://www.youtube.com/watch?v=h38yaRUpuTk (Fed Batch Process)		
6	17	Kinetics of fed batch reactors, CSTR	13/13.5,13.5.3	DOT-2			
6	18	Revision					

MID TERM EXAM							
Part 3 (another one fourth of total number of lectures)							
7	19	plug flow and its kinetics	13/13.5.8.1				
7	20	Air loop bioreactors and its kinetics	13/13.23	D0A-3	http://www.youtube.com/watch?v=KU6Fnde8NCg (Bubble Column Reactor)		
7	21	Down stream processing: Introduction, removal of microbial cells and other solid matters	10/10.1				
8	22	Foam separation	10/10.1,10.1.1				
8	23	filtration, industrial filters and its principles	10/10.1.3	DOS-3			
8	24	Centrifugation	10/10.2.1		http://www.youtube.com/watch?v=GOj-ObJWy8g (Centrifugation)		
9	25	Different types of rotors and industrial centrifuges	10/10.2.2				
9	26	Electrophoresis, Dialysis	2/10.10	DOT-3			
9	27	Extraction of intracellular and extracellular enzymes	10/10.5	DOA-4			
Part 4 (another one fourth of total number of lectures)							
10	28	Cell disruption	10/10.3				
10	29	Ultrafiltreration, Microfilteration	2/10.4,10.5	TPS			
10	30	Aqueous two phase	10/10.5	DOS-4			

		extraction system					
11	31	Super critical fluid extraction	2/10.7				
11	32	whole broth processing,effluent treatment	2/10.8				
11	33	Aerobic slug treatment process	2/13.7				
12	34	Anaerobic slug treatment process	2/13.7				
12	35	Fermentation economics: Introduction Raw material, labour cost	13/13.2,13.4.5	Dot-4			
12	36	Revision					
13	37	Spill over(Production of Alcohol)					
13	37	Spill over(Consideration for Plant Cell Reactor)					
13	39	Spill over(Consideration for Animal cell Reactor)					
14	40	Spill over(Production of Secondary Metabolites					
14	41	Spill over(Production of Acetone)					
14	42	Spill over(SOP,GMP,GLP)					

Notes: 1. Use S. No. Of the readings above

2. To be filled in on the date of delivery of lecture by the instructor

3. Put homework number from Homework Table (below) against the lecture in which planned to be assigned (by co-ordinator). The first homework should be planned for the 2nd week of classes and the last should be assigned at least two weeks before the last day of classes.

4. Do not write Lecture, OHP, LCD projector etc.

5. *DoA :Ddate of Allotment ; DoS : Date of Submission*

Details of Homework and Case Studies Planned:

Homework No.	Topics of the homework	Nature of Homework (Group/individual/fieldwork)	Actual DoA	Actual DoS	Actual date of of task evaluation
1	Sterilization air and media sterilizations, Design of batch sterilization process, Del factor, sterilization cycle, sterilization of fermenters	Group			
2	Design of a fermenter: Various other aspects related to designing, Fermenter for microbial processes, Fermenters for animal cell culture	Group			
3	Control and measurement equipments of fermenter, Control and measurement equipments of fermenter, pH and D.O. probes, Impeller and spargers	Group			
4	Kinetics of fed batch reactors, C.S.T.B.R and its kinetics, Air loop bioreactors and its kinetics, filtration, industrial filters and its principles, Centrifugation	Group			

All The detailed homework problems to be submitted attached as annexure

Scheme for CA: (out of 100)

Component	**Frequency**	**Marks for each**	**Total Marks**
Homework based tests/quizzes	3 best out of 4	HW:5; Test:10	45
Term paper	1	25	25
Lab performance (only if there is a lab component)			30
		Total	100

List of suggested topics for term paper [at least 15] (Student to spend about 15 hrs on any one specified homework)

S.No.	Topic
1	Design of batch sterilization process, Del factor, sterilization cycle

2	Viscuous nature of macromolecules
3	Filtration, industrial filters and its principles
4	Batch Reactor operation and its kinetics
5	C.S.T.B.R and its kinetics
6	Aerobic slug treatment process
7	Fermentation economics: designing concepts
8	Control and measurement equipments of fermenter
9	Fermenters for animal cell culture
10	Kinetics of fed batch reactors
11	plug flow and its kinetics and air lift reactor
12	Design of a fermenter: baffles, spargers, impellers
13	Continous sterilization process
14	Fermenters for plant cell culture
15	Fermenters for microbial processes

Instruction plan for Lab component List of experiments (Should plan for 10 weeks of laboratory, 5 before MTE, 5 after)

Expt. No.	Title*	Equipment /Materials used	Reference of Lab Manual
1	Fermentation of carbohydrates	Flask, shaker	
2a	Production and estimation of alkaline protease.	Autoclave, Petri plate,burner	
2b	Production and estimation of alkaline protease.	Autoclave, Petri plate, burner	
3a	Microbial production of cellulase by cellulolytic microorganism	Autoclave, Petri plate, burner	
3b	Microbial production of cellulase by cellulolytic microorganism	Autoclave, Petri plate,burner	
MID TERM EXAM			
4a	Determination of dry cell weight concentration in fermentation broth and its coorelation with optical density	Autoclave, flask, spectrophotometer	
4b	Determination of dry cell weight concentration in fermentation broth and its coorelation with optical density	Autoclave, flask, spectrophotometer	
5a	Amylase production test	Autoclave, Petri plate,burner	
5b	Amylase production test	Autoclave, Petri plate,burner	
6	Production of alcohol by fermentation	Flask, shaker	

*Attach for each experiment, the objectives and the complete list of equipment/ consumables required

Plan of experiments: Fill exp number to be performed by each group on each lab turn

(See the note on *Conduct of Laboratory Classes* attached herewith)

Lab. Turn	Date	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10

* Each experiment of the lab will be evaluated using the following relative scheme:

Component	**%**
Conduct/Performance/Execution	20
Written Record a. Observations b. Analysis c. Error Analysis d. Results and Discussions	50 (10) (20) (10) (10)
Viva – Voce	30

Plan for Tutorials : (Plan for 6 x T before MTE , 6 x T after MTE)

S. No.	Topic (s)	**Type of** pedagogical tool(s) planned (case analysis, problem solving, test, role play, business game etc)	Pedagogical tool **actually used –** mention the title. (case analysis, problem solving, test, role play, business game)	Date held for group A.	Date held for group B
1	Cell Growth Kinetics	**Problem Solving**			
2	Cell Death Kinetics	**Problem Solving**			
3	Sterilization	**Problem Solving**			

4	Batch Reactor	**Problem Solving**			
5	Fed Batch Reactor	**Problem Solving**			
6	Continuous Reactor	**Problem Solving**			
MID TERM EXAM					
7	Heterogenous and Homogenous reaction	**Problem Solving**			
8	Filteration	**Problem Solving**			
9	Centrifugation	**Problem Solving**			
10	Aqueous two phase extraction	**Problem Solving**			
11	Chromatography and electrophopresis	**Problem Solving**			
12	Activated sludge treatment	**Problem Solving**			

Prepared by (Instruction Planner: Name, signature & date)

Comments of Coordinator of Specialisation (COS) wherever this designation exists/ CoD-F (if any)

Signature & Date

Comments of HoD-F / HOF (if there is no HOD-F)

Signature & Date

GUIDELINES FOR PLANNING OF LAB CLASSES

1. There are two conflicting set of requirements in any lab course:

   (a) The need to have an experiment follow the material taught in the lab, and the need for detailed instructions, on one hand, and

   (b) The need to reduce the requirement of equipment on the other.

2. Depending on the cost of the equipment required, we may offer a lab course in any of the following modes:

   Whenever the cost of equipment is minor, we may do one experiment a day, with all students doing the same experiment on a given day. It must be ensured that no more than 4 students work on a set-up.

   The students groups may not work serially - since the lab work should be long enough to engage a student for at least 75% of the class time. Where the cost of equipment is not very low – but neither very high, we may use 4 sets of 3 experiments each. In this case, each class group will be divided in 9 groups of about 3 students each, and 3 set -ups of each experiment will be required. The instructions for the three experiments will be furnished in the first half hour of the class.

   In the next category, we may have two sets of five experiments with one set-up for each experiment. One set will be completed before the MTE and the other after MTE. In this case, the very first turn should be used to explain all five experiments to all students.

   In the last category are those experiments where equipment is very expensive, and hence only one set - up may be used for each experiment. In such cases, the first and second lab classes of the semester may be used to demonstrate all experiments to all students, and the students will subsequently do all on their own with minimum of instructions on each experiment. A total of ten experiments will be possible in this case.

3. The evaluation is to be done in two phases: phase 1 on the conduct of experiment has to be done while the student is conducting the experiment, and the phase II on the write-up, results and conclusion are to be done on the next turn. If the student is absent on the next turn, the evaluation may be done whenever he is present for the first time thereafter. In short, on each turn a student has to be evaluated (at her/his seat) on the result and discussion of the last experiment and on the conduct of the current experiment.

4. Good lab manuals must be ready before the beginning of the next term – properly vetted by the HoDs.