BIRLA INSTITUTE OF TECHNOLOGY
MESRA – 835215, RANCHI, INDIA

UG

Name: …… Roll No.: ……..

Branch: …… Signature of Invigilator: ……

Semester: VIth Date: 27/04/2022 (MORNING)

Subject with Code: **BE309 FERMENTATION ENGINEERING**

Marks Obtained	Section A (30)	Section B (20)	Total Marks (50)

INSTRUCTION TO CANDIDATE

1. The booklet (question paper cum answer sheet) consists of two sections. First section consists of MCQs of 30 marks. Candidates may mark the correct answer in the space provided / may also write answers in the answer sheet provided. The Second section of question paper consists of subjective questions of 20 marks. The candidates may write the answers for these questions in the answer sheets provided with the question booklet.
2. The booklet will be distributed to the candidates before 05 minutes of the examination. **Candidates should write their roll no. in each page of the booklet.**
3. Place the Student ID card, Registration Slip and No Dues Clearance (if applicable) on your desk. All the entries on the cover page must be filled at the specified space.
4. Carrying or using of mobile phone / any electronic gadgets (except regular scientific calculator)/chits are strictly prohibited inside the examination hall as it comes under the category of unfair means.
5. No candidate should be allowed to enter the examination hall later than 10 minutes after the commencement of examination. Candidates are not allowed to go out of the examination hall/room during the first 30 minutes and last 10 minutes of the examination.
6. Write on both side of the leaf and use pens with same ink.
7. The medium of examination is English. Answer book written in language other than English is liable to be rejected.
8. All attached sheets such as graph papers, drawing sheets etc. should be properly folded to the size of the answer book and tagged with the answer book by the candidate at least 05 minutes before the end of examination.
9. The door of examination hall will be closed 10 minutes before the end of examination. Do not leave the examination hall until the invigilators instruct you to do so.
10. Always maintain the highest level of integrity. Remember you are a BITian.
11. Candidates need to **submit the question paper cum answer sheets before leaving the examination hall**.

BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: B. Tech **SEMESTER:** VI
BRANCH: Biotechnology **SESSION:** SP / 22

SUBJECT: BE 309 FERMENTATION ENGINEERING

TIME: 2 HOURS

INSTRUCTIONS:

1. Attempt all the questions
2. The missing data if any may suitably be assumed
3. Before attempting the question paper make sure you have got the correct paper.
4. Marks for questions are mentioned against each question.
5. Total mark for the examination is 50.

SECTION A - 1x30 = 30 MARKS

Answer all the following multiple-choice questions. Write your answer choice serial number and the corresponding statement against the given serial number of the question. *(Ex: Q1. a) direct flow towards the walls of the reactor)*

1. Which of the following is absent in fermentation media?
a) Carbon
b) Nitrogen
c) Agar
d) Water

2. Which of the following is not a criterion to create a media?
a) It should be able to produce the maximum yield of product
b) It should be able to produce the maximum concentration of product
c) It should be easily sterilized
d) It should permit the maximum rate of product formation, no matter how costly it is

3. Which of the following is not a Carbon source?
a) Blackstrap molasses
b) Corn molasses
c) Beet molasses
d) Yeast extract

4. The specific oxygen uptake rate increases with increase in the dissolved oxygen concentration up to a certain point is referred to as
a) Static method
b) Shaking method
c) C_{crit}
d) V_{max}

5. In which of the following bioreactors, the particles are not immersed in liquid?
a) Airlift reactor
b) Stirred Vessel
c) Packed Bed
d) Trickle bed

6. Bubble column reactor cannot be used for

a) Highly viscous medium
b) Low viscous medium
c) Solid state medium
d) Liquid state medium

7. Which of the following fermenters are characterized by height to diameter ratio?

a) Tower fermenter
b) Airlift fermenter
c) Hollow fiber
d) Perfusion bioreactor

8. Which type of reactor, aeration is generally accomplished in a separate vessel?

a) Fluidized Bed
b) Trickle bed
c) Packed Bed
d) Stirred & Air driven reactors

9. Back mixing of gas occurs in homogenous flow in bubble column.

a) True
b) False

10. For high viscous fluids, air-driven reactors are preferred over stirred vessels.

a) True
b) False

11. The reason of using a flat disk in a Turbine is

a) to create high shear conditions
b) to breakup bubbles more efficiently than the impeller blades
c) all the above
d) to ensure that the bulk of the energy consumption occurs at the blades

12. Gas hold up, characterizing the hydrodynamics in a fermenter, mainly depends on the

a) superficial gas velocity
b) power consumption
c) Both (a) and (b)
d) gas concentration

13. Vortex formation in stirred tank reactors can be prevented by

a) installing baffles in the reactor
b) shifting the impeller to an off-centre position
c) Both (a) and (b)
d) using axial flow impellers

14. A flooded impeller will lead to poor oxygen transfer rates because

a) bubbles tend to coalesce under the impeller
b) bubbles tend to break down too rapidly under high shear conditions
c) bubbles tend to move too quickly through the bulk liquid
d) the cells clog up the surface of the bubble

15. The rate limiting step in the movement of oxygen from the gas phase in a bubble to the cell is the movement of oxygen molecules through

a) gas-liquid interface
b) bubble boundary layer
c) bulk liquid

d) gas phase

16. Fouling factor is used

a) In heat exchanger design as a safety factor
b) In the case of Newtonian Fluids
c) When a liquid exchanges heat with a gas
d) None of the above.

17. Pseudoplastic consume less power than Newtonian fluids?

a) True
b) False

18. What is the ratio of tank diameter to impeller diameter for Newtonian fluids?

a) 3:1
b) 2:1
c) 1:3
d) 1:2

19. The factors affecting K_{La} values in fermentation vessels are the following except

a) the air flow rate employed
b) the degree of agitation
c) the rheology properties of the medium
d) the presence of chelating agents

20. The degree of agitation affects in fermentation process except

a) It increases the contact time for bubbles in the medium
b) It plays a vital role in the oxygen transfer rate in agitated fermenter
c) It influences coalesces of air bubbles
d) It decreases thickness of liquid film at gas-liquid interface

21. Medium Rheology is

a) Medium flow characteristics
b) Air flow characteristics
c) Mass flow characteristics
d) Liquid flow characteristics

22. The value of fouling factor depends upon the

a) characteristic of process fluid.
b) velocity of process fluid containing suspended solids.
c) suspended solids in the fluid.
d) all (1), (2) and (3).

23. Swirling and vortex formation can be prevented by

a) using baffles
b) using diffusion ring with turbines
c) both (a) and (b)
d) none of the above

24. Why vortex formation is undesirable in the agitation of biological systems?

a) The collision between the cells, impeller and air bubbles will lead to cell damage
b) Poor mixing despite the use of high stirrer speeds
c) Mixing will not be in the turbulent region
d) All of the above

25. Power number is the ratio of

a) imposed forced to inertial force
b) buoyant force to inertial force
c) gravitation force to inertial force
d) imposed force to gravitational force

26. Power consumption is less in un-gassed fluids.

a) True
b) False

27. Power required for turbulent flow is independent of the viscosity of the fluid but proportional to fluid density", this statement is applicable to which type of regime?

a) Laminar regime
b) Turbulent regime
c) Transition regime
d) Streamline regime

28. In a shell and tube heat exchanger, the 'tube pitch' is defined as the

a) O.D. of the tube for square pitch.
b) shortest distance between two adjacent tube holes.
c) shortest centre to centre distance between adjacent tubes.
d) none of these

29. Triangular pitch tube layout as compared to square pitch in a shell and tube heat exchanger

a) permits the use of less tubes in a given shell diameter.
b) facilitates comparatively easier external cleaning because of large clearance.
c) permits the use of more tubes in a given shell diameter.
d) both (b) and (c).

30. In a shell and tube heat exchanger baffles are provided on the shell side to

a) Improve the heat transfer
b) Provide support for tubes
c) Prevent stagnation of shell side fluids
d) All the above

SECTION B - 20 MARKS

1. How do you define and characterize turbulence in fluid flow ? [3 Marks]

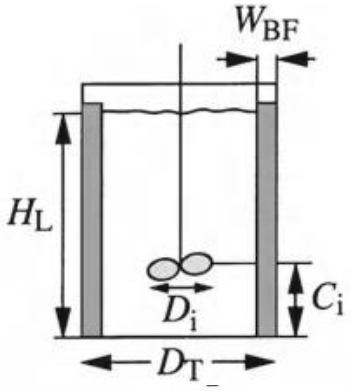
2. Discuss the key features of facility design of pharmaceutical products. [3 Marks]

3. Your team is designing a 1000-liter fermenter for a pilot scale operation. You are assigned the task of designing heat transfer equipment to the fermenter. You have the choice to choose between a jacketed type or an immersed coil type of heating. What are the factors you would consider in making your choice and why? [3 Marks]

4. A fermentation broth with viscosity 10^{-2} Pa s and density 1000 kg m^{-3} is agitated in a 50-m^3 baffled tank using a marine propeller 1.3 m in diameter. The tank geometry is as specified in the figure and table below. Calculate the power required for a stirrer speed of 4 s^{-1}.

[3 Marks]

DATA:



Impeller	D_i/D_T	H_L/D_T	C_i/D_T	Baffles	
				W_{BF}/D_T	Number
1. Rushton turbine $W_B/D_i = 0.2$, $L_B/D_i = 0.25$	0.33	1	0.33	0.1	4
2. Pitched-blade turbine $W_B/D_i = 0.125$, 6 blades, 45°, downward pumping	0.33	1	0.33	0.1	4
3. Marine propeller 3 blades, pitch = D_i	0.33	1	0.33	0.1	4

5. An industrial fermentation vessel with diameter 1.9 m and aspect ratio 3:1 is used for production of leucine by aerobic cultures of Serratia marcescens. At present, the fermenter is fitted with three Rushton turbines of diameter one-third the tank diameter. The impellers are spaced far enough apart so there is no significant interaction between their flow currents. The stirrer motor is rated for a maximum stirrer speed of 1.2 rps. It is proposed to carry out an impeller retrofitting operation to improve the performance of the culture. Although the culture is aerobic, the new stirring system will be designed for operation under nonaerated conditions as a safety precaution against accidental blockage of the air supply. It is decided to replace the two upper Rushton turbines with two identical downward-pumping hydrofoil impellers. The turbulent power number for the hydrofoil impellers is around 0.9. If the bottom Rushton impeller is replaced by a curved-blade disc turbine of diameter one-third the tank diameter,

a) What size hydrofoil impellers are required? [4 marks]
b) What assumptions are involved in your answer? [4 marks]

********** 27 APRIL 2022**********