7. Medium at a flow rate of 2 m^3 hr^{-1} is to be sterilised by heat exchange with steam in a continuous steriliser. The liquid contains bacterial spores at a concentration of 5×10^{12} m^{-3}. The activation energy and Arrhenious constant for thermal destruction of these contaminants 283 KJ $gmol^{-1}$ and 5.7×10^{39} hr^{-1}, respectively. A contamination risk of one organism surviving every 60 days' operation is considered acceptable. The steriliser pipe has an inner diameter of 0.1 m, the length of holding section is 24 m. The density of medium is 1000 kgm^{-3} and viscosity is 3.6 $kgm^{-1}hr^{-1}$. What sterilization temperature is required if Damkohler number (Da) corresponding to this system is taken as 42?

12

Group - E

8. (a) Explain the purification steps involved in recovery of penicillin from fermentation broth.

(b) "Mixed microbial culture is more suitable for biological treatment of wastewater" - justify the statement.

6 + 6 = 12

9. (a) Construct the model equations for plasmid instability related growth in a chemostat showing how (i) the rate of growth of plasmid containing cell is depended on rate of generation of plasmid free cell (ii) the rate of growth of plasmid free cell is depended on dilution rate of reactor (iii) rate of change of substrate is depended on specific growth rates of plasmid containing and plasmid free cells.

(b) A plasmid containing strain of *E. Coli* is used to produce recombinant protein in a 250 litre fermenter. The probability of plasmid loss per generation is 0.005. The specific growth rate of plasmid free cells is 1.4 hr^{-1}; specific growth rate of plasmid bearing cells is 1.2 hr^{-1}. Estimate the fraction of plasmid bearing cells after 18 hr growth if the inoculum contains only cells with plasmid.

(2 + 2 + 2) + 6 = 12

BIOPROCESS TECHNOLOGY
(BIOT 5203)

Time Allotted: 3 hrs **Full Marks: 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and Any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 x 1=10**

(i) Which of the following is a limitation of the autoclave?
(a) It takes too long to sterilize
(b) It lacks the ability to inactivate viruses
(c) It lacks the ability to kill endospores
(d) It will destroy heat labile materials.

(ii) Which of the following disinfectants act by disrupting microbial membranes?
(a) Cationic detergents (b) Halogens
(c) Heavy metals (d) Aldehydes.

(iii) Which of the following is best to sterilize heat labile solutions?
(a) Dry heat (b) Autoclave
(c) Membrane filtration (d) Pasturization.

(iv) The dilution rate, D is defined as
(a) F/V_R (b) V_R/F
(c) μ/F (d) F/μ.
(where F = volumetric flow rate, V_R = total volume of culture in the reactor and μ specific growth rate)

(v) 'Del Factor' is represented as
(a) $\ln N_o/N_t$ (b) $A.\, e^{-E/RT}$
(c) E/RT^2 (d) kN

(vi) The kinetic parameter(s) that is(are) affected during non-competitive inhibition is(are)
(a) V_{max} , K_m (b) V_{max}
(c) K_m (d) None of the above.

(vii) Wash out in steady state fermentation occurs when
(a) dilution rate is less than maximum specific growth rate
(b) dilution rate is higher than the maximum specific growth rate
(c) cell concentration reaches the maximum
(d) specific growth rate is maximum.

(viii) The phenomenon in which substrates are used in a sequential manner is known as
(a) trans-substrate genesis (b) dialism
(c) diauxic (d) multiplicity.

(ix) A higher *Km* value of Michaelis- Menten equation means
(a) greater affinity of enzyme to substrate
(b) lower affinity of enzyme to substrate
(c) unaffected with the substrate bonding
(d) lower dissociation constant value.

(x) The dissolved oxygen concentration in the medium below which the microbial system becomes oxygen limited is called
(a) saturation level (b) critical level
(c) optimum level (d) none of the above.

Group-B

2. The following data were obtained from enzymatic oxidation of phenol by phenol oxidase at different phenol concentrations.

S, mg/L	10	20	30	50	60	80	90	110	130	140	150
v,mg/(L.h)	5	7.5	10	12.5	13.7	15	15	12.5	9.5	7.5	5.7

i) What type of inhibition is this?
ii) Determine the constants $V_{m,}$, K_m and K_{Si} .
iii) Determine the oxidation rate at [S] = 70mg/L.

(4 × 3) = 12

3.(a) Derive a mathematical model for rate of enzyme reaction for non-competitive inhibition of enzyme reaction.

(b) Derive Brigg's Haldane Equation for enzyme - substrate reaction.

(c) What are the advantages of immobilization technique?

5 + 5 + 2 = 12

Group-C

4. The following data were obtained in a chemostat for the growth of *E. aerogenes* on a glycerol limited growth medium.

D, h^{-1}, Dilution rate	0.05	0.1	0.2	0.4	0.6	0.7	0.8	0.84
S, mg/ml, glycerol concentration	0.012	0.028	0.05	0.1	0.15	0.176	0.8	9.00
X, mg/ml, cell concentration	3.2	3.7	4	4.4	4.75	4.9	4.5	0.5

S_0 = 10mg / ml.
For this system estimate the values of K_s , μ_m , $Y_{x/s}$ and maintenance coefficient (m_s).

(4 + 4 + 4) = 12

5. Aerobic degradation of an organic compound by a mixed culture of organisms in waste water can be represented by the following reaction.

$$C_3H_6O_3 + aO_2 + bNH_3 \rightarrow cC_5H_7NO_2 + dH_2O + e\,CO_2$$

i) Determine a, b, c, d, and e if $Y_{x/s}$ = 0.4 gX/gS
ii) Determine the yield coefficients $Y_{x/O2}$ and $Y_{x/NH3}$
iii) Determine the degree of reduction for the substrate, bacteria and RQ for the organisms.

(4 + 4 + 4) = 12

Group - D

6. (a) What is half- life of enzyme?

(b) Prove that the half-life of an enzyme due to heat inactivation during sterilisation is equal to $0.693/K_d$, where K_d is the deactivation constant of that enzyme.

3 + 9 = 12