COMMONWEALTH OF AUSTRALIA

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Warning

CHARLES DARWIN UNIVERSITY

Family Name	
Given Names	
Student Number	
Teaching Period	Semester 1, 2016

FINAL EXAMINATION	**DURATION**
ENG446 – Bioprocess Engineering	Reading Time: **10** minutes Writing Time: **120** minutes

INSTRUCTIONS TO CANDIDATES

EXAM CONDITIONS

You may begin writing from the commencement of the examination session. The reading time indicated above is provided as a guide only.

This is a RESTRICTED OPEN BOOK examination

Any non-programmable calculator is permitted

One A4 sheet of handwritten double-sided notes permitted

No dictionaries are permitted

ADDITIONAL AUTHORISED MATERIALS	**EXAMINATION MATERIALS TO BE SUPPLIED**
none	1 x 20 Page Book

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Total Number of Marks: 100

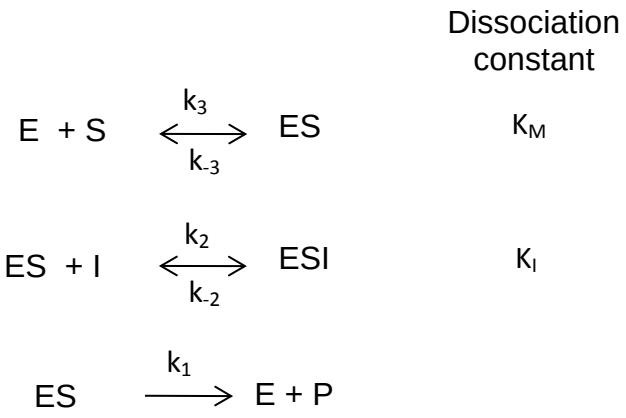
This exam should be answered in the Answer Booklet provided.

ANSWER ALL 4 QUESTIONS.

Marks for each question are indicated.

Question 1

The scheme below describes the mechanism for un-competitive enzyme inhibition where the inhibitor I binds only with the ES complex.



Derive the modified Michaelis-Menten equation for the overall rate of formation of P. Clearly explain any assumptions that you made in deriving the equation.

(Marks: 20)

Question 2

A chemostat is used for manufacturing a product whose formation is described by mixed-growth-associated product kinetics with the specific rate of product formation given by

$$q_p = \alpha\mu + \beta$$

where μ is the specific growth rate and α and β are constants. Assume that the culture follows Monod kinetics. The inlet substrate concentration is 1g/l.

The kinetic parameters are:

$\alpha = 0.1$; $\beta = 0.002\ h^{-1}$; $\mu_m = 0.7\ h^{-1}$; $K_s = 20$ mg/l; $Y_{xs} = 0.5$ g/g.

Calculate the productivity of the chemostat for product formation if it is operated at 50% of the critical dilution rate.

(Marks: 30)

Question 3

E. Coli is to be grown under aerobic conditions in a bioreactor with a wetted volume of 1000 l. It is known that oxygen becomes the limiting substrate due to mass transfer limitations. Under these conditions, the respiration rate q_{O_2} follows Monod kinetics:

$$q_{O_2} = \frac{q_{O_2 m} C_L}{K_{O_2} + C_L}$$

The maximum respiration rate $q_{O_2 m} = 240$ mg O_2 (g cell)$^{-1}$ h^{-1}, $K_{O_2} = 0.2$ mg/l and C_L is the dissolved oxygen (DO) concentration in the fermenter medium. A gas stream containing 80% oxygen is used to sparge the broth. Determine C_L when the cell concentration is 20 g/l.

Additional data: Prior to growing the culture, the unsteady state method was used to generate the following data:

At t = 1 min, $C_L = 24.2$ mg/l.

Beyond t = 7 minutes, the DO analyser reading stayed fairly constant around 28 mg/l.

(Marks: 25)

Question 4

A moving bed adsorption column packed with ion-exchange resin is used to separate an antibiotic from fermentation broth. The resin used has a density of 1.3 g/cm^3 and the bed is 20 cm in diameter with a porosity of 0.2. The column is designed so that the antibiotic in the effluent is 0.1 g/l for a feed solution containing 3 g/l of antibiotic . The superficial velocity of the liquid is 1.5 m/h and the overall mass transfer coefficient is 15 h^{-1}. The equilibrium relationship is given by:

$$C_s = 25\sqrt{C_L^*}$$

Where C_s^* is g solute/l resin and C_L^* g solute/l solution. Assume that the operating line can be approximated by:

$$\frac{C_L}{C_s} = 0.08$$

Determine the height of the packed bed column and the weight of resin in the bed.

(Marks: 25)