Name........................Student ID.......................................

PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Final Examination : Semester I | Academic year : 2009
Date : 29 September 2009 | Time: 9.00 – 12.00 am
Subject : 230-620 Advance Kinetics and Reactor Design | Room : R 300

ทุจริตในการสอบ โทษขั้นต่ำปรับตกในรายวิชานั้น และพักการเรียน 1 ภาคการศึกษา โทษสูงสุด ให้ออก

1. The exam are not allow to leave an exam room
2. All books, notes, and all computing devices (i.e., calculator and computer) are allowed
3. Do not discuss or ask any person during taking an exam
4. Do all problems, the mark of each problem is listed below

Problem No.	**Total Points**	**Point obtained**
1	15	
2	20	
3	15	
4	20	
5	30	
รวม	**100**	

Please note that the exam must consist of 9 pages (including the cover page)

Good luck and do your best on the exam
Assoc. Prof. Dr. Charun Bunyakan
Sep. 25, 2009

Name........................Student ID......................................

1. (15 points)
The hydrodealkylation of toluene from petroleum stocks to produce benzene and methane occurs in the gas phase at high temperature and involves free radical. The free radical mechanism is believed to proceed by the sequence

Initiation:

$$H_2 \xrightarrow{k_1} 2H^\bullet$$

Propagation :

$$H^\bullet + C_6H_5CH_3 \xrightarrow{k_2} C_6H_5^\bullet + CH_4$$

$$C_6H_5^\bullet + H_2 \xrightarrow{k_3} C_6H_6 + H^\bullet$$

Termination:

$$2H^\bullet \xrightarrow{k_4} H_2$$

The specific reaction rates k_1 and k_4 are defined with respect to H_2. Derive the reaction rate law for the rate of formation of benzene based on this mechanism.

Name.........................Student ID.....................................

2 (20 points)

Uncompetitive Substrate Inhibition, here the substrate ties up the enzyme-substrate complex by forming a substrate-enzyme-substrate complex, (S•E•S) which is inactive. The mechanisms are given below

$$E + S \underset{k_2}{\overset{k_1}{\rightleftarrows}} E \bullet S$$

$$S + E{\bullet}S \underset{k_4}{\overset{k_3}{\rightleftarrows}} S{\bullet}E{\bullet}S \text{ (Inactive)}$$

$$E{\bullet}S \xrightarrow{k_5} P + E$$

Show that the rate law for substrate Inhibition is

$$r_p = \frac{V_{max} S}{K_M + S\left(1 + \frac{S}{K_I}\right)} = \frac{K_I V_{max} S}{S^2 + K_I S + K_M K_I}$$

Name........................Student ID......................................

3. (15 points)
The thinned starch was converted to glucose by enzyme glucoamylase at 15°C and pH of 5.1. The initial rates for each experiment are given below.

C_S (mM)	5.5	8.33	11.11	13.89	16.66	22.22	27.77
r_p (mM/min)	0.163	0.211	0.241	0.276	0.301	0.339	0.347

Determine the Michalis-Menten parameters V_{max} and K_M.

Name..........................Student ID.......................................

4. (20 points)
From problem 3, if the total concentration of glucoamylase corresponding to the value of V_{max} is 30 mM, calculate the initial concentration of thinned starch which gave 90% conversion in batch reactor within 2 hr. The glucoamylase concentration is 15 mM.

Name........................Student ID.....................................

5. (30 points)
The data below were obtained in a steady state continuous stirred tank fermenter (CSTF/CSTR) for an uninhibited bioreaction. A feed of pure substrate at a concentration of 100 g/ dm^3 enters the fermenter at a volumetric flow rate of 10 dm^3/min.

(a) What are the Monod rate law parameters?
(b) What fermenter volume is required to produce an effluent product rate of 20 g/(dm^3 min) with a cell concentration of 20 g/ dm^3?

Additional data

r_g (g/ h. dm^3)	C_s (g/dm^3	C_C (g/dm^3)
1.10	100	1.0
0.71	50	1.0
0.40	20	1.0

and $Y_{p/s} = 0.1$ g/g

$Y'_{c/s} = 0.9$ g/g