## Prince of Songkla University
## Faculty of Engineering

Midterm Examination: Semester II                          Year 2005

Date: December, 14, 2005                                   Time 9.00-12.00

Subject: 230 – 501 Comp. Methods in Chem. Eng.            Room: R 300

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ทุจริตในการสอบ โทษขั้นต่ำ คือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

Please check the examination paper and write your name or code on the **answer book** before doing the examination.

- Calculator is allowed in the exam.

- Please notify the problem number and write the answers clearly.

- Taking the exam or the answer book outside the room is not allowed.

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**Problems**

1. (50 points) In chemical engineering, plug flow reactors are often used to convert reactants into products. It has been determined that the efficiency of the conversion can sometimes be improved by recycling a portion of the product stream so that it returns to the entrance for an additional pass through the reactor. The recycle rate is defined as

R = Volume of fluid returned to entrance/ volume leaving the system.

Suppose that we are processing a chemical A to generate a product B. For the case where A forms B according to an autocatalytic reaction, it can be shown that an optimal recycle rate must satisfy $\ln \dfrac{1 + R(1 - X_{AF})}{R(1 - X_{AF})} = \dfrac{R + 1}{R[1 + R(1 - X_{AF})]}$ where $x_{AF}$ = the fraction of reactant A

that is converted to products B. The optimal recycle rate corresponds to the minimum-sized reactor need to attain the desired level of conversion. Use a numerical method to determine the recycle ratios needed to minimize reactor size for a fractional conversion of $x_{AF}$ =0.95 by

1.1  Set algorithm (flow diagram) of solving by bisection method.

1.2  Set algorithm of solving by Newton-Raphson Method.

1.3  What is the answer of this problem?

2  (50 points)  Non-stiff ODEs

2.1 Set up equations for $\dfrac{d^2T}{dx^2} + h(T_a - T)^4 = 0$ and show algorithm of solving this problem by using Heun's Method.

2.2  Explain the effect of step size on the integration error.

2.3  Explain why Euler integration method provides lower accuracy than other method.

3  (50 points) Set the equations and algorithm for solving nonlinear stiff second order ODEs.

Dr. Kulchanat Kapilakarn