PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Midterm Examination: Semester I | Academic Year: 2006

Date: July 30, 2006 | Time: 9:00-12:00

Subject: 230-601 Advanced Engineering Mathematics for Chemical Engineers | Room: A200

อนุญาตให้นำเอกสารและเครื่องคำนวณทุกชนิดเข้าห้องสอบได้
ทุจริตในการสอบโทษขั้นต่ำคือปรับตกในรายวิชาที่ทุจริต
และพักการศึกษา 1 ภาคการศึกษา

Please do all 4 questions. Show all your work to receive full or partial credit. Final score is 110. (Total page = 3, including first page)

Question #	Total Score	Score
1.1	15	
1.2	15	
1.3	20	
2	15	
3	20	
4	25	
Total	110	

สุกฤทธิรา รัตนวิไล
ผู้ออกข้อสอบ

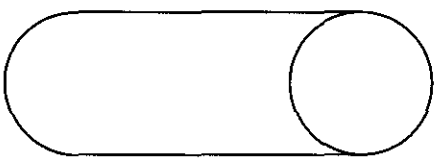
1. Solve the differential equation. (50 scores)

   1.1 $y'' + 3y' + 2y = 4x^2 + 10e^{3x}$ (15 scores)

   1.2 $y'' - 2y' + y = xe^x + 4e^x$
   Using Variation of Parameter Method. (15 scores)

   1.3 $x^2y'' - x(4-x)y' + (6-2x)y = 0$
   Can you solve this differential equation by Frobenius method? If you can, please show how to solve it. (20 scores)

2. A rod with constant physical properties as see below. Develop the differential equation describing the steady state temperature of rod, T(x), as a function of position x.
   Note: 1. **Only** develop the differential equation.
   2. Explain which method you would like to use as a tool to solve this equation.
   Assume: one dimensional conduction along the rod and air temperature is equal To. (15 scores)



   Rod: - diameter, D
   - length, L
   - thermal conductivity, k
   Heat transfer coefficient, h, as a function of T(x)
   h = aT(x)+b; a and b are constant

3. (As a part of your homework) two vertical, cylinder tanks, each 10 m high, are installed side-by-side in a tank farm, their bottoms at the same level. The tank are connected at their bottoms by a horizontal pipe 2 meters long, with pipe inside diameter 0.03 m. The first tank (1) is full of oil and the second tank (2) is empty. Moreover, tank 1 has a cross-sectional are twice that of tank 2. The first tank also has another outlet (to atmosphere) at the bottom, composed of a short horizontal pipe 2 m long, 0.03 m diameter. Both of the valves for the horizontal pipes are opened simultaneously. What is the maximum oil level in tank 2? Assume laminar flow in the horizontal pipes, and neglect kinetic, entrance-exit losses. Draw your figure. (20 scores)

4. Three tanks of 10,000 gal capacity are arranged so that when water is fed into the first tank, an equal quantity of solution overflows into the second tank. Likewise discharge from the second enters into the third and from the third to some point outside the system. Agitators keep the contents of each tank uniform (these are CSTMs- Continuously Stirred Tank Mixers). Initially all tanks have a concentration Co lb/gal of a solute. Water flows into the first tank at a flow rate of 10 gal/min. Calculate the time required to reduce the concentration in the first tank to 0.1Co; calculate the concentration in the other two tanks at this time. Draw your figure. (25 scores)

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