

PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Midterm Examination: Semester I

Academic Year: 2007

Date: July 29, 2007

Time: 9:00-12:00

Subject: 230-601 Advanced Engineering
Mathematics for Chemical Engineers

Room: A201

อนุญาตให้นำเอกสารและเครื่องคำนวณทุกชนิดเข้าห้องสอบได้
ทุจริตในการสอบโทษขั้นต่ำคือปรับตกในรายวิชาที่ทุจริต
และพักการศึกษา 1 ภาคการศึกษา

Please do all 4 questions. Show all your work to receive full or partial credit.
Final score is 135. (Total page = 9, including first page)

Question #	Total Score	Score
1.1	10	
1.2	15	
1.3	15	
1.4	20	
1.5	10	
2	20	
3	25	
4	20	
Total	135	

สุกฤทธิรา รัตนวิไล
ผู้ออกข้อสอบ

1. Solve the differential equation. (70 scores)

1.1 $y'' - y' - 6y = 12xe^x$ (15 scores)

1.2 $x^2 y'' + xy' - y = x$

Using Variation of Parameter Method or Inverse Operator Method. (15 scores)

1.3 $x^2 y' + 2xy - y^3 = 0$ (15scores)

1.4 $(x^2 + 1)y'' + xy' - y = 0$

Can you solve this differential equation by Power Series method?
If you can, please show how to solve it. (20 scores)

1.5 The general solution for ODE is

$$y = k_1 e^{(\lambda + \mu i)x} + k_2 e^{(\lambda - \mu i)x}$$

Rewritten this solution in term of $\sin(\mu x)$ and $\cos(\mu x)$ (10 scores)

2. Cylindrical metal rod is use as promoters on the exterior of a hot surface with surface temperature of $700\text{ }^{\circ}\text{C}$. The ambient air flowing around the cylindrical metal rod has a temperature of $30\text{ }^{\circ}\text{C}$. (20 scores)
- The metal conductivity = k (sec . cm . K)
 - The heat transfer coefficient = h (m^2 . hr . $^{\circ}\text{C}$)
- 2.1 Formulate steady state differential equation of metal rod temperature (T) in the x direction (X is directed outward from the hot surface, and rod radius is R)
- 2.2 Find the characteristic root s for the ODE in part 2.1

3. Consider a tank with a 500 L capacity that initially contains 200 L of water with 100 kg of salt in solution. Water containing 1 kg of salt/L is entering at a rate of 3 L/min, and the mixture is allowed to flow out of the tank at a rate of 2 L/min. (25 scores)
- 3.1 Formulate differential equation between $C_A(t)$ and time (t)
 $C_A(t)$ is the concentration of salt at time t
- 3.2 Determine the concentration (kg/L) of salt in the tank at the point of overflowing.

4. Suppose that in a certain autocatalytic chemical reaction a compound A reacts to form compound B. Further, suppose that the initial concentration of A is C_{A0} and that $C_B(t)$ is the concentration of B at time t . Then $C_{A0} - C_B(t)$ is the concentration of A at time t . (20 scores)

Reaction rate $\frac{dC_B(t)}{dt} = kC_B(t)(C_{A0} - C_B(t))$

Determine $C_B(t)$ if $C_B(0) = C_{B0}$

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