1. In a photochemical reaction chamber, the initial concentrations of NO, NO_2, O_3, and O_2 are $[NO]_o$, $[NO_2]_o$, $[O_3]_o$, and zero, respectively. Find the concentration of O_3 at any time if the primary reactions are (20分)

$NO_2 + light \rightarrow NO + O$, rate constant = k_1

$O + O_2 \rightarrow O_3$, rate constant = k_2

$O_3 + NO \rightarrow NO_2 + O_2$, rate constant = k_3

2. The temperature distribution in space is T(x,y,z) = xy+yz+zx. (a) Find the direction cosines of the direction in which the temperature changes most rapidly with distance from the point (1,1,1) and determine the maximum rate of change. (b) Find the derivative of T in the direction of vector 3**i**-4**k** at point (1,1,1). (15分)

3. A solid consists of one-half of a right circular cylinder of radius b height h. The lower base, the curved surface, and the vertical plane face are maintained at constant temperature T = 0. Over the upper base the temperature is a known function of position $T(r, \theta, h) = f(r, \theta)$. Compute the steady state temperature distribution in the solid. (20分)

4. Use two different methods to solve the differential equation (20分)

$$\frac{\partial u}{\partial t} = \alpha \frac{\partial^2 u}{\partial x^2}, \quad t>0, \ 0<x<\infty \text{ with } u(x,0) = u_0, \ 0<x<\infty$$

$$t>0, \ u(0,t) = u_1 \text{ and } u(\infty,t) = u_0$$

5. Find the general solutions for the following equations (各5分)

(a). $y'' + (y')^2 + 1 = 0$ (b) $y' + y \ln y = y e^y$

6. Please derive the error term of the trapezoidal method for the integration of $\int_a^b f(x)dx$ if the (b-a) is divided into n equispaced intervals. (15分)