ZCE 111
Assignment 2

Q1: Planck's radiation law

- Plot Planck's law of black body radiation for temperatures 1000 K, 2000 K, 3000 K, … , 10000 K on the same graph for wavelength from 0 to 1000 nm.

$$R(\lambda, T) = \frac{2\pi hc^2}{\lambda^5\left(e^{hc/\lambda kT} - 1\right)}$$

- Your plots must be properly customized: It should contain labels on each axis and a title. The plots should be fully shown for all ranges of values involved. It should also contains a legend indicating the temperatures associated with each curve.

Q2: Wein's displacement law

- Try to manually locate , the wavelength at which *R*(λ,T) is maximum for a fixed *T*.

Write a Do loop to automatically do this. Hence, generate the list $\{\{\lambda_{max1},T_1\}, \{\lambda_{max2},T_2\}, \{\lambda_{max3},T_3\}, \{\lambda_{max4},T_4\},\ldots\}$ automatically.

- Hence, proof Weinmann's displacement law (recall your ZCT 104 Modern physics class).

Q3: Series representation of functions

- Construct the series representation of a function $f(x)$ using up to N_0 terms, $\sum_{n=0}^{n=N_0} c_n\, x^n$.
- Plot $\sum_{n=0}^{n=N_0} c_n\, x^n$ along with the generating function $f(x)$ on the same graph.
- The functions and their series representations are given in the following slides.

$$(i)\, f(x) = \frac{1}{1-x};$$

$$series\ representation \sum_{n=0}^{n\to\infty} c_n x^n = x^0 + x^1 + x^2 + x^3 + x^4 + \cdots; -1 < x < 1$$

$$(ii)\, f(x) = \frac{1}{1+x};$$

$$series\ representation \sum_{n=0}^{n\to\infty} c_n x^n = x^0 - x^1 + x^2 - x^3 + x^4 - x^5 + \cdots; -1 < x < 1$$

$$(ii)\, f(x) = \ln(1+x);$$

$$series\ representation \sum_{n=0}^{n\to\infty} c_n x^n = x^1 - \frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{4} + \frac{x^5}{5} + \cdots; -1 < x < 1$$

Q4: Taylor polynomial for e^x at $x = 0$

Taylor series representation for the exponential function $f(x) = e^x$ at x=0 up to order n is given by

$$P_n(x) = \sum_{k=0}^{k=n} \frac{f^{(k)}(x)}{k!}\bigg|_{x=0} x^k = \frac{e^0}{0!}x^0 + \frac{e^0}{1!}x^1 + \frac{e^0}{2!}x^2 + \frac{e^0}{3!}x^3 + \ldots \frac{e^0}{n!}x^n$$

$$= 1 + x + \frac{x^2}{2} + \frac{x^3}{3!} + \ldots \frac{x^n}{n!}$$

Construct the Taylor series representation up to N_0 = 3, 5, 10 terms. Plot $P_3(x), P_5$ and P_{10} along with the generating function $f(x) = e^x$ on the same graph. Label each plot with a legend. Plot $P_3(x)$ in red, $P_5(x)$ in blue, $P_{10}(x)$ in black, $f(x)$ in yellow (use the Help in Mathematica)