PYL 102 HW Problem – DUE ON August 8, 2024

1. Consider a 1-D system consisting of electrons of mass m which is acted upon by a weak periodic potential described by the Fourier series $V(x) = V_0 + V_1 \frac{cos2\pi x}{a} + V_2 \frac{cos4\pi x}{a} + \cdots$
   (a) Under what conditions will the nearly free electron approximation work? Assuming that the condition is satisfied, sketch the three lowest energy bands in the 1st BZ.
   (b) Calculate the energy gap at $k = \pi/a$ (between the 1st and 2nd band) and at $k = 0$ (between the 2nd and 3rd band).

   [Hint: Apply your PYL 101 knowledge of calculating the energy eigenstates using operator algebra]

   [6 marks]