PH3201 Class Test 1. **13** February 2025 11:10-11:50

1. Consider a chemical reaction $\mathrm{X} \underset{k_1}{\overset{k_2}{\rightleftharpoons}} \mathrm{A}$.

Assume that the concentration of [A] = *a* is fixed and let the number of X reactants are denoted by the random variable *n*. The degradation and generation rates are $W_d = k_2 n$ and $W_g = k_1 a$

(a) Write the master equation for P(*n,t*) (b) solve for the steady state P(*n*). (c) Write the characteristic function hence determine (d) mean(*n*) and variance(*n*). [**8 Marks**]

2. Consider an isolated system of *N* non-interacting particles. Each particle can be in two energy states $\pm\epsilon$ and the total energy of the system is *E*.

Let $x = \dfrac{E}{N\epsilon}$ such that $x \in [-1 : +1]$

The plot of $\dfrac{2\epsilon}{k_B T}$ vs x is given in the figure.

Determine the function. [**7 Marks**]