Problem 1 (10 Points) Find the integral
\[ \int_0^\pi \sin t \, dW \]
where \( W \) is the Wiener process. Find the expected value and variance of the integral.

Problem 2 (10 Points) Find the integral for the following and also show the main steps of its derivation.
\[ \int_0^T W \, dW \]

Problem 3 (10 Points) Show that for \( G \in L^2[0, T] \)
\[ E \left( \left( \int_0^T G \, dW \right)^2 \right) = E \left( \int_0^T G^2 \, dt \right) \]

Problem 4 (10 Points) Using Gronwall lemma, i.e.
\[ f \geq 0, \, \phi \geq 0, \, \phi(t) \leq C_0 + \int_0^t f \phi \, ds, \Rightarrow \phi(t) \leq C_0 \exp \int_0^t f \, ds \]
provide the sufficient condition and prove the uniqueness of the solution to the SDE
\[ dX = b(X, t) \, dt + B(X, t) \, dW \]