ME2 Computing- Session 5: Advanced Numerical Integration and Differentiation

Learning outcomes:
- Being able to compute Simpson and Adaptive Simpson Integration
- Being able to compute K-th order derivative
- Being able to combine numerical derivative and interpolation

Before you start:
In your H drive create a folder *H:\ME2MCP\Session5* and work within it.

Please provide feedback at: www.menti.com with code 79 79 176

Task A: Simpson Integration and Adaptive Simpson Integration

1. Write a function, *Simpson*, to integrate over a uniformly distributed set of nodal point.

2. Write an adaptive script to integrate numerically a given function *f(x)*, over a prescribed domain, until a desired tolerance is achieved.
   Test it by integrating $f(x) = \sin(x)$ over the domain [0:2π].

Task B: K-th order derivative

Write a function, *Derivative*, to compute the *k-th* order derivative for a given set of uniformly distributed nodal points (choose yourself to apply either the forward or backward scheme).

Task C: Smoothing derivatives with polynomial interpolation

1. Set the function *f(x) = sin(x)* within the domain [0:π] with 10 nodal points, (x_n, y_n).

2. Compute the 5-th derivative of these nodal points, by using the function *Derivative* from Task B. Plot the scattered nodal points and the derivative.

3. Interpolate, with Lagrangian polynomials, the nodal points (x_n, y_n), for 100 points over the same domain [0:π]. Recompute the 5-th derivative for the interpolated points. Plot the scattered nodal points and the derivative.