ME 5400 Homework – Numerical Integration and Differentiation

Evaluate the following integrals using (a) the Trapezoidal Rule, (b) Simpson's 1/3 Rule, (c) Simpson's 3/8 Rule and (d) Gauss Quadrature

1. $\int_0^3 8x^2 e^x dx$

2. $\int_{0.5}^{1.5} 4^{2x} dx$

3. $\int_{-1}^{1}\int_{0}^{2} (2x^2 - 3y^2 + xy^3)\, dx\, dy$

4. $\int_{-2}^{2}\int_{0}^{2}\int_{-3}^{1} (x^3 - 3yz) dx\, dy\, dz$

5. Determine the distance traveled for the following data:

t(min)	1	2	3.25	4.5	6	7	8	9	9.5	10
v(m/s)	4.5	6	5.5	7	8.5	8	6	7.5	7	6

Use (a) the Trapezoidal Rule, (b) the best combination of the Trapezoidal Rule and Simpson's Rules and (c) Gauss Quadrature on cubic splines fit across the entire data set.

6. Use regression to estimate the acceleration at each time for the following data with second, third, and fourth-order polynomials. Plot the results.

t(sec)	1	2	3.25	4.5	6	7	8	8.5	9.3	10
v(m/s)	10	11	13	14.5	17	16	12	13	14	10

7. The velocity *v* (m/s) of air flowing past a flat surface is measured at several distances y (m) away from the surface. Determine the shear stress τ (N/m^2) at the surface (y=0). Assume μ = 1.8 × 10^{-5} N-s/m^2.

$$\tau = \mu \frac{dv}{dy}$$

y (m)	0	0.002	0.006	0.012	0.018	0.024
v (m/s)	0	0.287	0.897	1.915	3.045	4.296

8. Chemical reactions often follow the model

$$\frac{dc}{dt} = -kc^n$$

where *c* = concentration, *t* = time and *k* = reaction time and *n* = reaction order. Given values of *c* and *dc/dt*, *k* and *n* can be evaluated by a linear regression of the logarithm of the model. Use this approach along with the following data to estimate *k* and *n*.

t	10	20	30	40	50	60
c	3.52	2.48	1.75	1.23	0.9	0.65