Advanced Higher - Mathematics of Mechanics

Unit 3

Outcome 1.1 Applying Algebraic Skills	**NS**	**OT**	**VG**
I know how to expand an expression of the form $(ax + by)^n$ using the binomial expansion where $n \leq 7$, using $(x+a)^n = \sum_{k=0}^{n} \binom{n}{k} x^k a^{n-k}$.			
I can express a proper rational function as a sum of partial fractions where the denominator is of the type: $\frac{7x+1}{x^2+x-6}$ (linear factors)			
I can express a proper rational function as a sum of partial fractions where the denominator is of the type: $\frac{5x^2-x+6}{x^3+3x}$ (irreducible quadratic factor)			
I can express a proper rational function as a sum of partial fractions where the denominator is of the type: $\frac{3x+10}{x^2+6x+9}$ (repeated factor)			
Reduce an improper rational function to a polynomial and a proper rational function by division or otherwise eg. $\frac{x^3+2x^2-2x+2}{(x-1)(x+3)}$			

Outcome 1.2 Applying Calculus Skills to Differentiation	**NS**	**OT**	**VG**
I can differentiate functions involving: tan *x*, sec *x*, cosec *x*, cot *x*.			
I can differentiate functions involving: e^x, ln *x*			
I can differentiate functions using the chain rule $\big(f(g(x))\big)' = f'(g(x)).g'(x)$			
I can differentiate functions using the product rule $\big(f(x)g(x)\big)' = f'(x)g(x) + f(x)g'(x)$			
I can differentiate functions using the quotient rule $\left(\frac{f(x)}{g(x)}\right)' = \frac{f'(x)g(x)-f(x)g'(x)}{(g(x))^2}$			
I can differentiate functions which require more than one application of the chain rule, product rule or quotient rule			
I know that $\frac{dy}{dx} = \frac{1}{dx/dy}$			
I can apply differentiation to simple rates of change eg rectilinear motion, optimisation.			

I can use parametric differentiation to find the first and second derivatives.			
I can apply differentiation to related rates in problems where the functional relationship is given explicitly eg. motion in a plane.			
I can solve practical related rates by first establishing a functional relationship between appropriate variables.			
I can differentiate functions expressed implicitly eg. find $\frac{dy}{dt}$ given $\frac{dx}{dt}$ and the function $x^2 + y^2 = r^2$ and *x* and *y* are functions of *t.*			

Outcome 1.3 Applying Calculus Skills to Integration	**NS**	**OT**	**VG**
I know and can use standard results including $\int e^x dx$, $\int \frac{1}{x} dx$, $\int sec^2 x \, dx$			
I can integrate using a substitution when the substitution is given.			
I can integrate a simple product or quotient of functions when one function is the derivative of the other.			
I can integrate proper rational functions using partial fractions.			
I can use one or repeated applications of integration by parts.			
I can apply integration to a range of physical situations including to evaluate areas, volumes by revolution and the centre of mass of a uniform lamina bounded by curves.			

Outcome 1.4 Applying Calculus Skills to Differential Equations	**NS**	**OT**	**VG**
I can find a general solution of a first order differential equation where the variables can be separated.			
I can solve a linear first order differential equation using an Integrating Factor.			
I can solve second order homogeneous equations where the auxiliary equation has real roots.			
I can formulate a simple statement involving rate of change as a separable first order differential equation.			
I can find general solutions and solve initial value problems, for example, mixing problems, growth and decay problems, simple electronic circuits and simple examples of damped simple harmonic motion			