ES201 Homework Set #1 [Math Review]

Note: You do not need to use the problem solving format (Known, Find, Given, Analysis) for these problems; however, produce a solution that is legible, organized, and easy for the grader to follow. Use engineering problem paper and do not write on the back of the page. Maple code can and should be included where used. Indicate what you are solving so the grader (and you when you revisit the problem later) can understand what was asked for and what was done. **Do not just write down a list of answers.**

Problem 1.1

Six different functions are listed below:

(a) $p(t) = t^3 - t + 5$　　　　　　(b) $p(\theta) = 2\cos(2\theta)$　　　　　　(c) $g(z) = \dfrac{1}{\sqrt{z}}$ with $z \geq 0$

(d) $f(z) = 1 - e^{-3z}$　　　　　　(e) $r(t) = \dfrac{5}{t}$

For each function listed above do the following:

…. Find the first derivative of each function with respect to the independent variable, *e.g.* find dp/dt: (Please indicate how you found your answer: Maple, Table of Derivatives, by hand, etc.)

…. Find the *indefinite integral* of each function with respect to the independent variable, *e.g.* find $\int p(t)dt$. (Please indicate how you found your answer: Maple, Table of Integrals, by hand, etc).

Problem 1.2

A first-order ordinary differential equation describes the behavior of a system:

Case I: $\dfrac{dz}{dt} = a$　　　　　Case II: $\dfrac{dz}{dt} = \dfrac{a}{t}$　　　　　Case III: $\dfrac{dz}{dt} = \dfrac{1}{\sqrt{z}}\dfrac{a}{t}$

where a is a constant. From observing the behavior of the system we also know that $z = z_1$ when $t = t_1$. Answer the two questions below for each case:

(a) Which variable is the *independent* variable, z or t? Which is the *dependent* variable, z or t?

(b) Using *separation of variables*, solve for $z(t)$. (Please show all your work even if you use Maple to check your results.) Your answer will be in symbols and include a, z_1 and t_1. Given numerical values for a, z_1, and t_1, you should be able to find numerical values for z as a function of t.

Problem 1.3

(a) Find the time rate of change of the following quantities:

Case I: Mass　　　　　　　　$m = \rho \forall$　　　where ρ is a constant and $\forall = 5\big[2 + \cos(2t)\big]$

Case II: Linear momentum:　$P_x = m V_x$　　　where $m = 2\exp(-0.1t)$ and $V_x = 4\sin\left(3t + \dfrac{\pi}{4}\right)$

(b) Find the following definite integrals:

Case I: Total mass　　　　　$m = \displaystyle\int_{\forall_1}^{\forall_2} \rho\, d\forall$　　　where $\rho = \dfrac{2}{1 + \forall}$

Case II: Total work done　　$W = \displaystyle\int_{\forall_1}^{\forall_2} p\, d\forall$　　　where $p = 6\forall^{-1.4}$

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