PHYSICS 306

HOMEWORK #1

ALL PROBLEMS ARE WORTH 10 POINTS

1. Starting from first principles derive the rule for the derivative of the quotient of two functions $f(x)$ and $g(x)$: $D[f/g] = (gDf - fDg)/g^2$.

2. Following the discussion in class derive the "Rule of 72" from first principles: The number of years n required to double an initial principal at an interest rate r is $n \cong 72/R$, where $R = 100r$. Use this rule to estimate n for $r = 5, 7$, and compare to the exact result.

3. Shankar, problem 1.4.1

4. Shankar, problem 1.5.1

5. Shankar, problem 1.6.1

6. Shankar, problem 1.6.2

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HOMEWORK #2

1. Text problem 1.6.2.

2. Text problem 1.6.3:

   a) Use the "Rule of 72"

   b) Follow the solution suggested by the text.

3. Text problem 1.6.7

4. Text problem 1.6.8

5. Text problem 1.6.9

6. The volume of a 3-dimensional sphere of radius R is $V(R) = (4/3)\pi R^3$. Suppose that R is increased by ΔR. Calculate the resulting change in the volume.

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HOMEWORK #3

ALL PROBLEMS ARE WORTH 10 POINTS

1. Using Tables, guesses, or whatever other means you choose find the anti-derivatives $F(x)$ corresponding to the following functions $f(x)$. Show by explicit differentiation that you have found the correct expression for $F(x)$.

   a) ℓnx

   b) $\dfrac{1}{x^2+a^2}$

   c) $\tan x$

   d) $\sin^2 x$

   e) $\cos^2 x$

   f) $\tanh x$

   g) $\dfrac{1}{\sqrt{x^2 \pm a^2}}$

   h) b^{ax}; b, a are constants

   i) $\dfrac{x}{\sqrt{x^2 \pm a^2}}$

2. Text problem 2.1.3

3. Text problem 2.1.4

4. Text problem 2.2.1

5. Text problem 2.2.2

6. Text problem 2.2.6

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HOMEWORK #4

ALL PROBLEMS ARE WORTH 10 POINTS

1. Text problem 2.2.3

2. Text problem 2.2.4

3. Text problem 2.2.8

4. Text problem 2.2.9

5. Text problem 2.2.10

6. Text problem 2.2.11

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HOMEWORK #5

ALL PROBLEMS ARE WORTH 10 POINTS

1. (a) Verify the following integral

$$f(x,a) \equiv \frac{1}{a\sqrt{\pi}} \int_{-\infty}^{\infty} e^{-x^2/a^2} dx = 1$$

(b) Show that the function $\delta(x)$ defined by

$$\delta(x) = \lim_{a \to o} f(x,a)$$

has the property that $\delta(x) = o$ when $x \neq o$. $\delta(x)$ is called the Dirac delta function.

2. Evaluate $I = \int_{-\infty}^{\infty} e^{-by^2} y^4 dy$

3. Consider the function $f(x,y) = \sqrt{R^2 - x^2 - y^2}$, with $x^2 + y^2 \leq R^2$
   (a) Find the derivatives $f_x, f_y, f_{xx}, f_{yy}, f_{xy}$ and f_{yx}.
   (b) Show that $f(x,y)$ has a maximum at the origin.

4. Fill in the steps leading to Eq.(3.1.25) of the text.

PHYSICS 306
HOMEWORK #6

1. Shankar problem P 3.1.4
2. Shankar problem P 3.1.6
3. Shankar problem P 3.1.7
4. Shankar problem P 3.2.1 - provide an explanation for every step.
5. Shankar problem P 3.2.5
6. Shankar problem P 3.2.6

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HOMEWORK #7

1. Problem 4.2.5.

2. Problem 4.2.6

3. Equation 4.3.12 fill in all details.

4. Problem 4.3.3

5. Problem 4.3.4

6. Problem 4.3.7

PHYSICS 306
HOMEWORK #8

1. Shankar Problem P 6.1.5 - show that f(x,y) satisfies the Cauchy-Riemann Conditions
2. Consider the function $f(x,y) = x^2 + y^2$:

   a. Is $f(x,y)$ analytic?

   b. Perform a change of variables and convert $f(x,y) \longrightarrow f(z,\bar{z})$. Does this function depend on $\bar{z}$?
3. Shankar Problem 6.4.1
4. Shankar Problem 6.4.8