Matlab Reference Sheet for Physics

Amanuel Anteneh

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This PDF contains instructions on how to use Matlab to do mathematical calculations that I've used at least somewhat frequently while doing my undergraduate physics degree. You are to free to use/edit it as you see fit.

1 System of Equations:

Example:

$$s = x\cos\phi + y\sin\phi$$

$$\phi = -x\sin\phi + y\cos\phi$$

In Matlab:

```
>> syms x, y, phi, s
>> eqns = [cos(phi)*x + sin(phi)*y == s, -sin(phi)*x + cos(phi)*y
== phi]
>> S = solve(eqns,[x y])
```

To display solution for x type S.x and similarity for y type S.y. If you wanted to solve for phi and s the command would be solve(eqns, [theta s]) instead. Although the equation may not be easily solvable for Matlab due to its non-linearity.

2 Differentiation

Single Variable Derivative:

Example: $\frac{d}{dx}(\ln(x^2)) = \frac{2}{x}$

In Matlab:

```
>> syms x
>> diff(log(x^2))
```

3 Integration

Symbolic Single Integral:

Example: $\int_0^R 2\pi r \sin\theta \, dr = \pi R^2 \sin\theta$

In Matlab:

```
>> syms r theta R
>> fun = 2*pi*r*sin(theta)
>> int(fun, 'r', 0, R)
```

Symbolic Double Integral:

Example: $\int_0^L \int_0^{x^2+1} xy \, dy \, dx = \frac{L^2(L^4+3L^2+3)}{12}$

In Matlab:

```
>> syms x y L
>> fun = x*y
>> int(int(fun, 'y', 0, x^2 + 1), 'x', 0, L)
```

For triple integrals simply wrap expression in another int().

4 Matrix Algebra

Finding Eigenvalues and Eigenvectors:

Example: $\begin{bmatrix} 1 & 6 & 0 \\ -3 & 1 & 0 \\ 0 & 4 & 1 \end{bmatrix}$

In Matlab:

```
>> A = [1 6 0; -3 1 0; 0 4 1]
>> [V,D] = eig(sym(A))
```

Returns a diagonal matrix D with eigen values along the diagonal and a matrix V whose columns are the corresponding eigen vectors. Use sym(A) instead of just A so that answer is given symbolically instead of numerically, e.i. $\lambda_2 = 1$ - 2^(1/2)*3i instead of $\lambda_2 = 1.0000$ - 4.2426i.

Invert Matrix:

Example: $\begin{bmatrix} 1 & 6 & 0 \\ -3 & 1 & 0 \\ 0 & 4 & 1 \end{bmatrix}$

In Matlab:

```
>> A = [1 6 0; -3 1 0; 0 4 1]
>> inv(sym(A))
```

5 Differential Equations