

Department of Electrical Engineering
University of Arkansas



A Tutorial on Matlab

Ch. 4 Symbolic Operations

Dr. Jingxian Wu
wuj@uark.edu

SYMBOLIC OPERATIONS

- **Symbolic operation:**
 - **Analytically** solving and manipulating symbolic mathematical expressions
 - All discussions in previous chapters are based on **numerical** solutions: variables must have values
 - In symbolic operations, the variables do not need to have a value
 - For example, we can use symbolic operation to perform integration or differentiation

SYMBOLIC OPERATIONS

- **Declare symbol variables**

- Declare the variables a, b, x as symbolic variables (they do not have numerical values),

- Define a symbolic function $f(x) = x^a e^{-bx}$

```
>> syms a b x % declare symbolic symbols
```

```
>> f = x^a*exp(-b*x) % use symbolic symbols to define a symbolic function
```

```
f =
```

```
x^a/exp(b*x)
```

SYMBOLIC OPERATIONS

- **Differentiation**

- Find the first derivative of $f(x) = x^a e^{-bx}$
 - With $f(x)$ defined in the previous slide

```
>> diff_f = diff(f, x) % differentiation
```

```
diff_f =
```

```
(a*x^(a - 1))/exp(b*x) - (b*x^a)/exp(b*x)
```

```
>> simplify(diff_f) % ask Matlab to simplify the results
```

```
ans =
```

```
(x^(a - 1)*(a - b*x))/exp(b*x)
```

SYMBOLIC OPERATIONS

- **Integration**

- Find the indefinite integral of $f_2(x) = xe^{-ax}$

```
>> syms a x
```

```
>> f2 = x*exp(-a*x)
```

```
f2 =
```

```
x/exp(a*x)
```

```
>> int_f = int(f2, x) % indefinite integral
```

```
int_f =
```

```
-(a*x + 1)/(a^2*exp(a*x))
```

SYMBOLIC OPERATIONS

- **Integral (cont'd)**

- Calculate

$$\int_0^{10} x e^{-ax} dx$$

>> int(f2, x, 0, 10)

ans =

$$1/a^2 - (10*a + 1)/(a^2*\exp(10*a))$$

SYMBOLIC OPERATIONS

- **Substitution**

- The “subs” command substitute a number of a symbol into a symbolic expression
- Example: evaluate the value of $f(x) = x^a e^{-bx}$ when $a = 2$, $b = 1$, and $x = 3$

```
>> syms a b x
```

```
>> f = x^a*exp(-b*x)
```

```
f =
```

```
x^a/exp(b*x)
```

```
>> subs(f, {a, b, x}, {2, 1, 3})
```

```
ans =
```

```
0.4481
```

```
>>
```

SYMBOLIC OPERATIONS

- **Substitution**

- Example:

- Evaluate the integral of $\int_0^{10} x e^{-ax} dx$ when $a = 2$

```
>> syms a x
```

```
>> f2 = x*exp(-a*x)
```

```
f2 =
```

```
x/exp(a*x)
```

```
>> int_f2 = int(f2, 0, 10)
```

```
int_f2 =
```

```
1/a^2 - (10*a + 1)/(a^2*exp(10*a))
```

```
>> subs(int_f2, a, 2)
```

```
ans =
```

```
0.2500
```

```
>>
```


SYMBOLIC OPERATIONS

- **Graphing functions with ezplot**

- Example: plot $f(x) = x^a e^{-bx}$ when $a = 2$ and $b = 1$ for x in the range of $[0, 10]$

```
>> syms x y a b
```

```
>> f = x^a*exp(-b*x);
```

```
>> f3 = subs(f, {a, b}, {2, 1})
```

```
f3 =
```

```
x^2/exp(x)
```

```
>> ezplot(f3, [0, 10])
```

