Key to MATLAB Exercise 5 – Symbol Computation

1.

```
>> a1=1/4+1/6                    % double
>> a2=sym(1/4+1/6)               % sym
>> a3='1/4+1/6'                  % char
>> a4='1/4+1/6'; eval(a4)        % rational
```

2.

1) a)

```
>> clear; c1=a+2*a; c1
??? Undefined function or variable 'a'.
```

b)

```
>> clear; c2='a+2*a'; c2
c2 =
a+2*a
```

Conclusion. It is illegal in the statement of "c1=a+2*a" of a) where 'a' is not defined before we assign data to variable c1. But "c2=a+2*a" of b) is right, due to here 'a' being a character.

2) a)

```
>> clear; c3='a+2*a'; eval(c3)
??? Error using ==> eval
Undefined function or variable 'a'.
```

b)

```
>> clear; c4='a+2*a'; a=3; eval(c4)
ans =
     9
```

3) a)

```
>> clear; syms a; c5='a+2*a'; eval(c5)
ans =
3*a
```

b)

```
>> clear; syms a; c6= a+2*a; eval(c6)
ans =
3*a
```

c)

```
>> clear; syms a; c7=sym('a+2*a'); subs(c7, a, 2)
ans =
     6
```

d)

```
>> clear; syms a; c8=sym('a+2*a'); subs(c8, 2)
ans =
     6
```

4) a)

```
>> clear; c9=sym(' a+2*a+b'); c9
```

```
c9 =
a+2*a+b
```

b)

```
>> clear; c10=sym('a+2*a+b'); subs(c10, 1)
ans =
3*a+1
```

c)

```
>> clear; c11=sym(' a+2*a+b'); subs(c11, a, 1)
??? Undefined function or variable 'a'.
```

d)

```
>> clear; syms a; c12=sym('a+2*a+b'); subs(c12,a,1)
ans =
3+b
```

e)

```
>> clear; syms a b; c13=sym('a+2*a+b'); subs(c13,a,1, b,2)
??? Error using ==> sym.subs
Too many input arguments.
```

f)

```
>> clear; syms a b; c14=sym('a+2*a+b'); subs(c14, [a,b], [1, sym('pi')])
ans =
3+pi
```

3.

1)

```
>> syms x; f=x^3-6*x^2+11*x-6; g=(x-1)*(x-2)*(x-3); h=x*[x*(x-6)+11]-6;
>> expand(g)
ans =
x^3-6*x^2+11*x-6
>> expand(h)
ans =
x^3-6*x^2+11*x-6
```

2)

```
>> f actor(f)
ans =
(x-1)*(x-2)*(x-3)
```

3)

```
>> horner(f)
ans =
x*(x*(x-6)+11)-6
```

4.

1)

```
>> syms x; f=[x^(-3)+6*x^(-2)+12*x^(-1)+8]^(1/3)
f =
(1/x^3+6/x^2+12/x+8)^(1/3)
>> simple(f)
```

```
simplify:
((2*x+1)^3/x^3)^(1/3)
radsimp:
(2*x+1)/x
combine(trig):
((1+6*x+12*x^2+8*x^3)/x^3)^(1/3)
factor:
((2*x+1)^3/x^3)^(1/3)
expand:
(1/x^3+6/x^2+12/x+8)^(1/3)
combine:
(1/x^3+6/x^2+12/x+8)^(1/3)
convert(exp):
(1/x^3+6/x^2+12/x+8)^(1/3)
convert(sincos):
(1/x^3+6/x^2+12/x+8)^(1/3)
convert(tan):
(1/x^3+6/x^2+12/x+8)^(1/3)
collect(x):
(1/x^3+6/x^2+12/x+8)^(1/3)
mwcos2sin:
(1/x^3+6/x^2+12/x+8)^(1/3)
ans =
  (2*x+1)/x
>> simplify(f)
ans =
((2*x+1)^3/x^3)^(1/3)
>> pretty(f)
```

```
/ 1      6     12      \1/3
|---- + ---- + ---- + 8 |
|  3     2     x       |
\ x     x              /
```

It implies that the result is $\left(\frac{1}{x^3}+\frac{6}{x^2}+\frac{12}{x}+8\right)^{\frac{1}{3}}$.

Omitted 2) to 6).

5.

```
>>clear; syms a x y; s=a*sin(x)+exp(y)
s =
a*sin(x)+exp(y)
```

1)

```
>> syms t; subs(s, y, log(t))
ans =
```

```
a*sin(x)+ t
```

2)

```
>> subs(s,{x,y},{pi/3,0})
ans =
1/2*a*3^(1/2)+1
```

6.

1)

```
>> clear; syms a x y; p=a+x*y+2*x*y^2+3*x^2*y
p =
a+x*y+2*x*y^2+3*x^2*y
>> collect(p, x)
ans =
3*x^2*y+(y+2*y^2)*x+a
```

2)

```
>> collect(p, y)
ans =
2*x*y^2+(x+3*x^2)*y+a
```

7.

```
>> A=randn(2); syms x; s=3*x^2-2*x+5;
>> polyvalm(sym2poly(s), A)
ans =
    5.2187    4.6712
    8.7431   13.0285
```

Notice: subs(s, A) cann't be used here, because it equals to 3.*A.*A+5.*[1, 1; 1, 1]-2.*A.

8.

```
>> clear; syms x; f=exp(-x)
f =
exp(-x)
```

1)

```
>> subs(f, 0)
ans =
     1
```

2)

```
>> subs(f, eps)
ans =
    1.0000
```

3)

```
>> a=[1:1:20]; format short; subs(f, a)
ans =
  Columns 1 through 9
    0.3679    0.1353    0.0498    0.0183    0.0067    0.0025    0.0009
0.0003    0.0001
  Columns 10 through 18
    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000    0.0000
```

```
    0.0000    0.0000
  Columns 19 through 20
    0.0000    0.0000
```

9.

```
>> syms a b c d u v s t; s_a=[a b;c d]; s_b=[u v;s t];
```

1)

```
>> s_a+s_b
ans =
[ a+u, b+v]
[ c+s, d+t]
```

2)

```
>> 2 * s_a
ans =
[ 2*a, 2*b]
[ 2*c, 2*d]
```

3)

```
>> s_a * s_b
ans =
[ a*u+b*s, a*v+b*t]
[ c*u+d*s, c*v+d*t]
```

4)

```
>> s_a .* s_b
ans =
[ a*u, b*v]
[ c*s, d*t]
```

5)

```
>> s_a\s_b
ans =
[ (-b*s+u*d)/(a*d-c*b),     -(b*t-v*d)/(a*d-c*b)]
[ -1/(a*d-c*b)*(c*u-a*s),       (a*t-c*v)/(a*d-c*b)]
```

6)

```
>> s_a/s_b
ans =
[ (-s*b+a*t)/(u*t-v*s), (-v*a+u*b)/(u*t-v*s)]
[ -(s*d-c*t)/(u*t-v*s),    (u*d-v*c)/(u*t-v*s)]
```

7)

```
>> s_c=s_a+i*s_b
s_c =
[ a+i*u, b+i*v]
[ c+i*s, d+i*t]
```

8)

```
>> s_c'
ans =
[ conj(a+i*u), conj(c+i*s)]
```

```
[ conj(b+i*v), conj(d+i*t)
```

9)

```
>> s_c.'
ans =
[ a+i*u, c+i*s]
[ b+i*v, d+i*t]
```

10)

```
>> det(s_a)
ans =
a*d-c*b
```

11)

```
>> inv(s_a)
ans =
[ d/(a*d-c*b), -b/(a*d-c*b)]
[ -c/(a*d-c*b),    a/(a*d-c*b)]
```

10.

1)

```
>> syms x ; b=[1;x];
>> a=[1 2; 3 4]; syms y; y=inv(a)*b
y =
        -2+x
  3/2-1/2*x
```

Omitted 2) to 6).

11.

1)

```
>> a=[1 2;3 4]; [v,d]=eig(a)
v =
    -0.8246    -0.4160
     0.5658    -0.9094
d =
    -0.3723          0
          0     5.3723
```

2)

```
>> a=[sym(1) sym(2); sym(3) sym(4)]
a =
[ 1, 2]
[ 3, 4]
>> [v, d]=eig(a)
ans =
v =
[                    1,                    1]
[ 3/4+1/4*33^(1/2), 3/4-1/4*33^(1/2)]
d =
[ 5/2+1/2*33^(1/2),                    0]
```

```
[                    0, 5/2-1/2*33^(1/2)]
```

3)

```
>> syms x ; a=[sym(1) sym(x);sym(3) sym(4)]
a =
[ 1, x]
[ 3, 4]
>> [v, d]=eig(a)
v =
[ -1/2+1/6*(9+12*x)^(1/2), -1/2-1/6*(9+12*x)^(1/2)]
[                       1,                       1]
d =
  [ 5/2+1/2*(9+12*x)^(1/2),                       0]
[                       0, 5/2-1/2*(9+12*x)^(1/2)]
```

4)

```
>> syms s t u v; a=[s t;u v]; [v,d]=eig(a)
v =
[                                   -(-1/2*s+1/2*v-1/2*(s^2-2*s*v+v^2+4*t*u)^(1/2))/u,
-(-1/2*s+1/2*v+1/2*(s^2-2*s*v+v^2+4*t*u)^(1/2))/u]
[                                                                                    1,
1]
d =
[                                     1/2*s+1/2*v+1/2*(s^2-2*s*v+v^2+4*t*u)^(1/2),
0]
[                                                                                    0,
1/2*s+1/2*v-1/2*(s^2-2*s*v+v^2+4*t*u)^(1/2)]
```

12. For example 2)

```
>> [u,t]=schur(a)
??? Function 'schur' is not defined for values of class 'sym'.
Error in ==> schur at 30
   [varargout{1:nargout}] = builtin('schur', varargin{:});
>> [l,u]=lu(a)
??? Function 'lu' is not defined for values of class 'sym'.
Error in ==> lu at 54
   [varargout{1:nargout}] = builtin('lu', varargin{:});
>> [u,v,t]=svd(a)
u =
[ -.40455358483375693164244872262782, -.91451429567730445267917697381021]
[ -.91451429567730445267917697381021,  .40455358483375693164244872262780]
v =
[ 5.4649857042190426504511884932842,                                   0]
[                                 0, .36596619062625782042296438426142]
t =
[ -.57604843676632079133109858194273,  .81741556047036327308865238846391]
[ -.81741556047036327308865238846391, -.57604843676632079133109858194273]
```