Let A be the matrix below

In [1]:
```
A=[5   9 -4   3   4;
 -2  -6   0  -9  -4;
  1   2  -2  -8  -7;
  2  -5  -8   5  -7;
 -6  -7   1  -3  -3]
```

1. Consider the following functions
   f(x) = exp(x)
   f(x) = 2/x + 3 + 5x^3
   f(x) = x*exp(x)

For each function compute a matrix that has the same eigenvectors as A, but whose eigenvalues are f(lambda) where lambda is an eigenvalues of A. Verify that the eigenvalues are as you expect. Make sure you understand what is going on. Note that in Julia and MATLAB, expm is the matrix exponential, while exp is the element-wise exponential.

Turn in your eigenvalue computation and the function applied to the eigenvalues:

1. The third function f(x) = x*exp(x) is the derivative of exp(tx) with respect to t, at t=1.
   What is the corresponding matrix derivative? Do a simple finite difference to compute the matrix derivative that is accurate to three or four places.

In [2]:
```
λ=eigvals(A)  # Note: You can type \lambda<tab> for the charact
er λ
```

In [3]:
```
s=v->sort(v,by=real)  # create a simple sort_by_real_part funct
ion
```

In [4]:
```
#1. f(x)=exp(x)
[eigvals(expm(A)) exp(λ)]
```

In [5]:
```
#sorting by real part makes it easier to see
[s(eigvals(expm(A))) s(exp(λ))]
```

In [6]:
```
#2. f(x) = 2/x + 3 + 5x^3
[s(eigvals(2*inv(A) + 3*I + 5*A^3)) s(2./λ+3+5*λ.^3)]
```

In [7]:
```
#3. f(x)= x*exp(x)
[s(eigvals(A*expm(A))) s(λ.*exp(λ))]
```

In [8]:
```
A*expm(A)
```

In [9]:
```
#Finite Difference Approximation to d/dt exp(At) at t=1
h=.000001
t=1
(expm(A*t*(1+h))-expm(A*t))/h
```

In [ ]:
```
```