EM314 - NUMERICAL METHODS
ASSIGNMENT - 2

Hisni Mohammed M.H.

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Implementation

Q4.

Applications

Q5. **Kepler's Equation.**

Kepler's Equation can be rewritten as,

$$f(E) = E - e\sin(E) - M$$

Implementation of this function in OCTAVE,

OCTAVE Code (f.m)

```
function y = f(x)
    M = 3;
    e = 0.8;
    y = x - e*sin(x)-M;
endfunction
```

Newton's method is used to solve this equation. OCTAVE Code (newtons.m) written in Question 4 is used.

OCTAVE code (q6.m)

```
x0 = 4;
tol = 10^(-8);
nmax = 100;
[zero, res, itr] = newtons(@f,@df,x0,tol,nmax)
```

Output of the code

```
>> q5
zero =  3.0629
res =  0.0000000088119
itr =  88
```

Therefore, angle E = 3.0629 rad.

Q6. **State Equation of a Gas**

The Van der Waals equation can be rewritten as,

$$f(V) = pV^3 - (Nbp + kNT)V^2 + (aN^2)V - abN^3$$

Implementation of this function in OCTAVE,

OCTAVE Code (f.m)

```
function y = f(x)
    p=3.5*(10^7);
    a=0.401;
    N=1000;
    b=42.7*10^(-6);
    k=1.3806503*(10^(-23));
    T=300;
    y = p*(x.^3) + a*(N^2)*x - a*b*(N^3) -(N*b*p+k*N*T)*x.^2;
endfunction
```

OCTAVE Code (bisection.m)

```
function [zero, res, niter] = bisection(f,a,b,tol,nmax)
    x = [a (a+b)/2 b];
    y = f(x);
    niter = 0;
    I = (b-a)/2;
    if y(1)*y(3)>0
        error('The signs of the function at the extrema must be opposite');
    elseif y(1) == 0
```

```
            zero = a; res = 0; return


        elseif y(3) == 0
            zero = b; res = 0; return
        end
while ( I >= tol && niter <= nmax )
        if sign(y(1))*sign(y(2))<0
            x(3) = x(2); x(2) = (x(1) + x(3))/2;
            y = f(x); I = (x(3)-x(1))/2;
        elseif sign(y(2))*sign(y(3))<0
            x(1) = x(2); x(2) = (x(1) + x(3))/2;
            y = f(x); I = (x(3)-x(1))/2;
        else
            x(2) = x(find(y ==0)); I = 0;
        end
            niter = niter+1;
        end
        if niter > nmax
            fprintf('bisection method exited without convergence');
        end
        zero = x(2); res = f(x(2));
        endfunction
```

Bisection method is used to solve f(V) = 0.

OCTAVE code (q6.m)

```
a = 0; b = 1;
```

```
tol = 10^(-12); nmax = 100;
[zero, res, niter] = bisection(@f,a,b,tol,nmax)
```

Output of the code

```
>> q6
zero =  0.042700
res =  0.00000040785
niter =  39
```

Therefore, the volume = $0.0427m^3$