

---

## Table of Contents

.....	1
Handle-functions .....	1
Ex.1 Analytical solve .....	1
Ex.1 Numeric solve .....	2
Ex.2 abs(psi)^2 (Analytical solve) .....	3
Ex.2 abs(psi)^2 (Numeric solve) .....	4
Ex.3 $E \sim n$ An. and Num. solves .....	5
Ex. 4 An. and Num. solves for $n \gg 10$ .....	9
Ex. 5 (Advanced) $E_n \sim n$ by numeric solve .....	10

```
clc, clear, close all
load 'constants.mat'
```

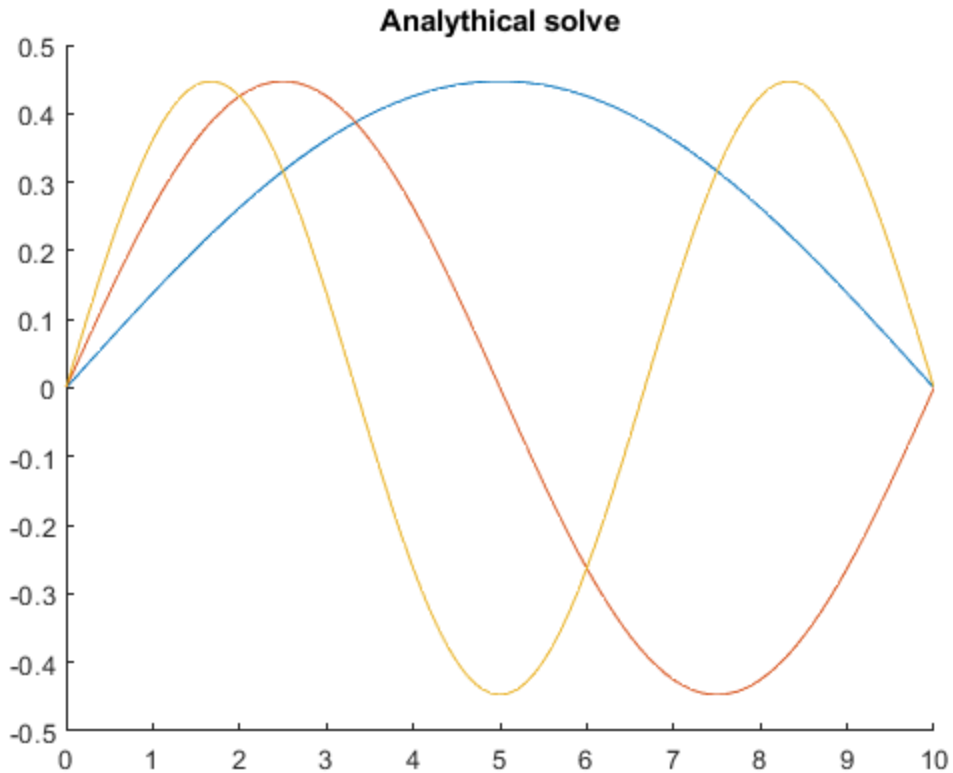
## Handle-functions

```
Energy = @(n, L, meff) (hbar * pi * n / (L * 1e-9))^2 / (2 * meff * m0) *
    J2eV * 1e3;
```

## Ex.1 Analytical solve

In ex.1 we need to compare analytical and numeric solves for  $n = 1, 2, 3$  by plotting.

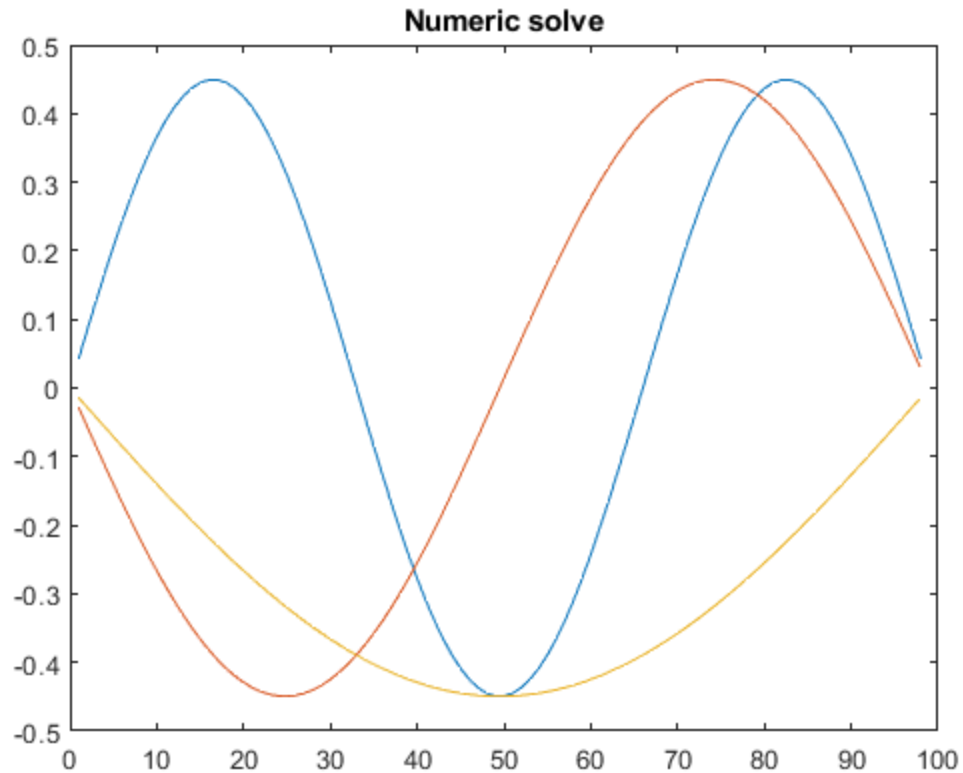
```
figure('Name', 'Analytical solve')
hold on
L = 10;
x = 0:0.1:L;
h = 1/10;
for n = 1:3
    Psin = sqrt(2 / L) * (sin(pi * n * x / L));
    plot(x, Psin)
end
title('Analytical solve')
hold off
```



## Ex.1 Numeric solve

```
figure('Name', 'Numeric solve')
N = 98;
I = eye(N, N);
T = I;
for i = 1:N
    for j = 1:N
        if i == j
            T(i, j) = -2;
            continue
        end
        if i == j - 1 || i == j + 1
            T(i, j) = 1;
        end
    end
end
[psi, D] = eig(T);
psi = psi ./ sqrt(h);
disp(sum(psi(:,N-2).^2)*h) % Make sure numbers are correct (need to = 1)
plot(1:N, psi(:,N-2), 1:N, psi(:,N-1), 1:N, psi(:,N))
title('Numeric solve')
```

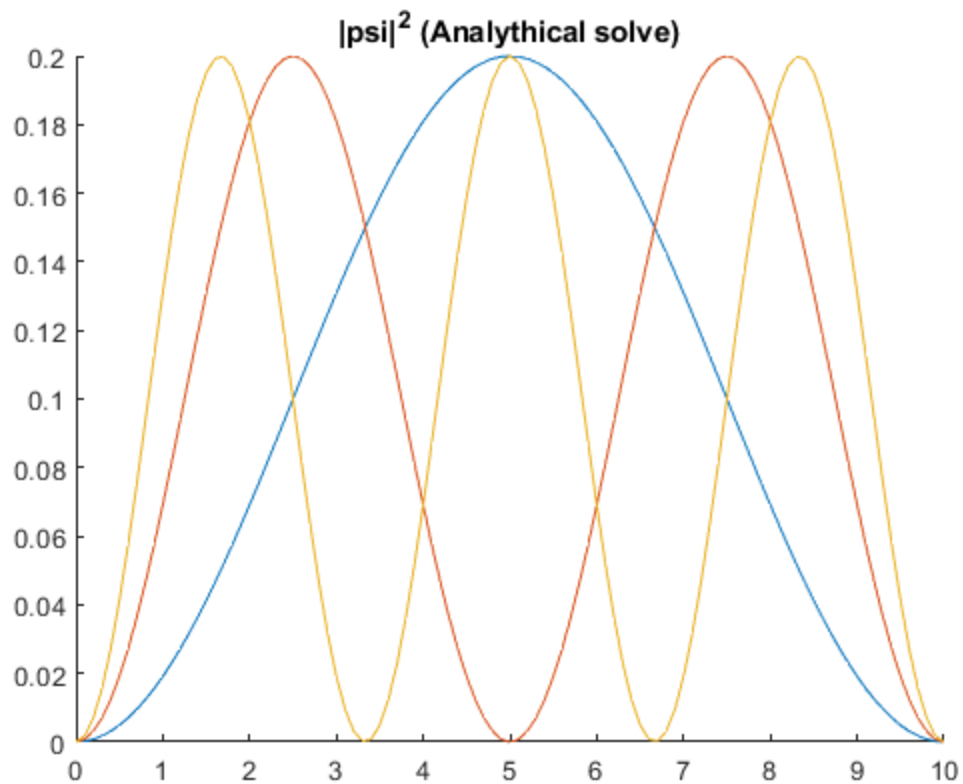
1.0000



## Ex.2 $\text{abs}(\psi)^2$ (Analythical solve)

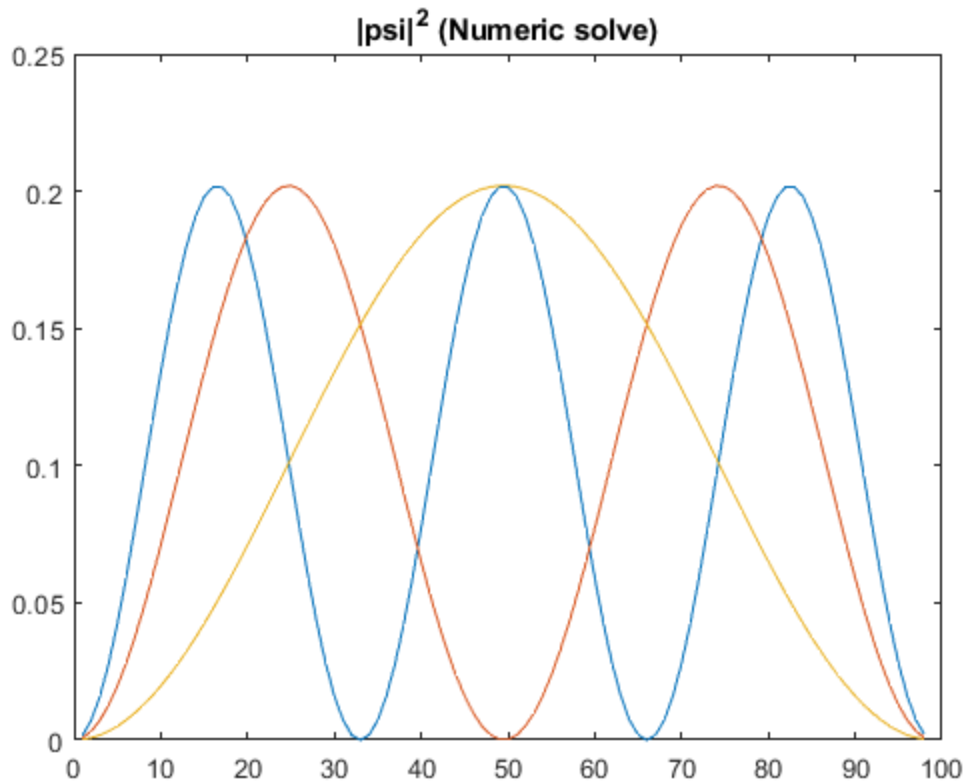
In ex.2 we need the same thing we had in ex.1 but for  $\text{abs}(\psi)^2$

```
figure('Name', 'abs(ψ)^2 (Analythical solve)')
hold on
for n = 1:3
    Psin = sqrt(2 / L) * (sin(pi * n * x / L));
    plot(x, abs(Psin).^2)
end
title('|ψ|^2 (Analythical solve)')
hold off
```



## Ex.2 $\text{abs}(\psi)^2$ (Numeric solve)

```
figure('Name', 'abs(psi)^2 (Numeric solve)')
abPsi = abs(psi).^2;
plot(1:N, abPsi(:,N-2), 1:N, abPsi(:,N-1), 1:N, abPsi(:,N))
title('|psi|^2 (Numeric solve)')
```



## Ex.3 E~n An. and Num. solves

In ex.3 we need to compare analytical and numeric connection between E and n by plotting. Also we need to try high n values (n = 10, 50, 90)

```
figure('Name', 'E~n Num. solves (n = 1...5)')
E = hbar^2 * diag(D) / (h^2 * 2 * m0);
hold on
for n = 1:5
    x = [0 10];
    y = [E(n); E(n)];
    text(11, E(n), strcat('n=', num2str(n)))
    plot(x, y)
    xlim([0 12]);
end
plot([10 10], get(gca, 'Ylim'), 'k');
title('E~n Num. solves (n = 1...5)')
hold off

figure('Name', 'E~n Num. solves (n = 10, 50, 90)')
hold on
for n = [10 50 90]
    x = [0 10];
    y = [E(n); E(n)];
    text(11, E(n), strcat('n=', num2str(n)))
    plot(x, y)
```

---

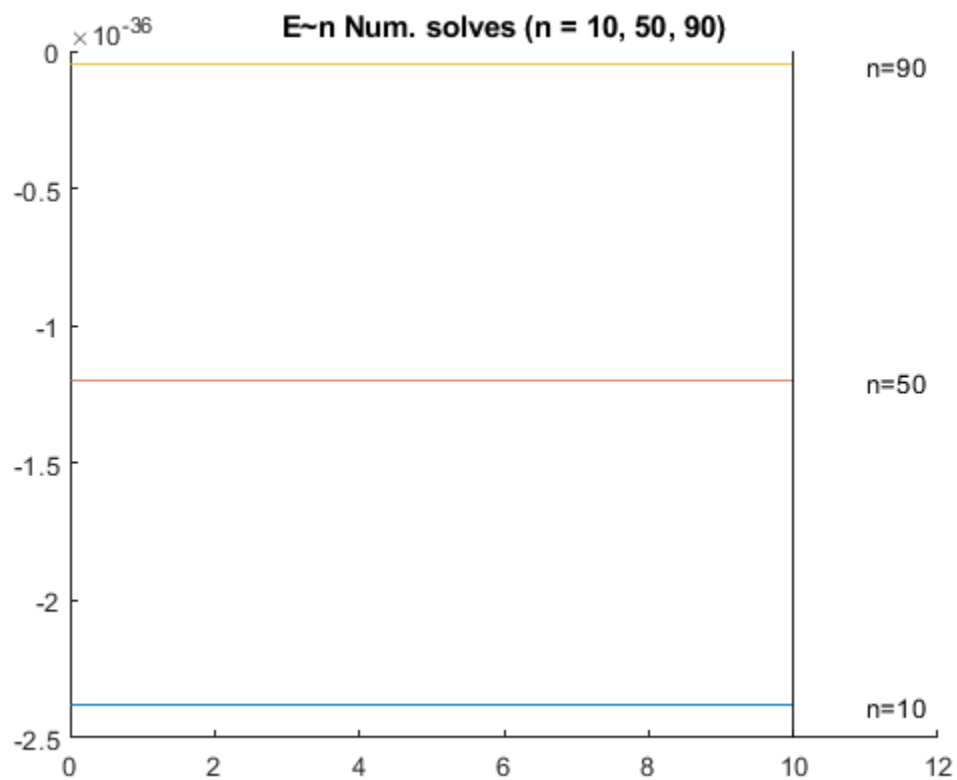
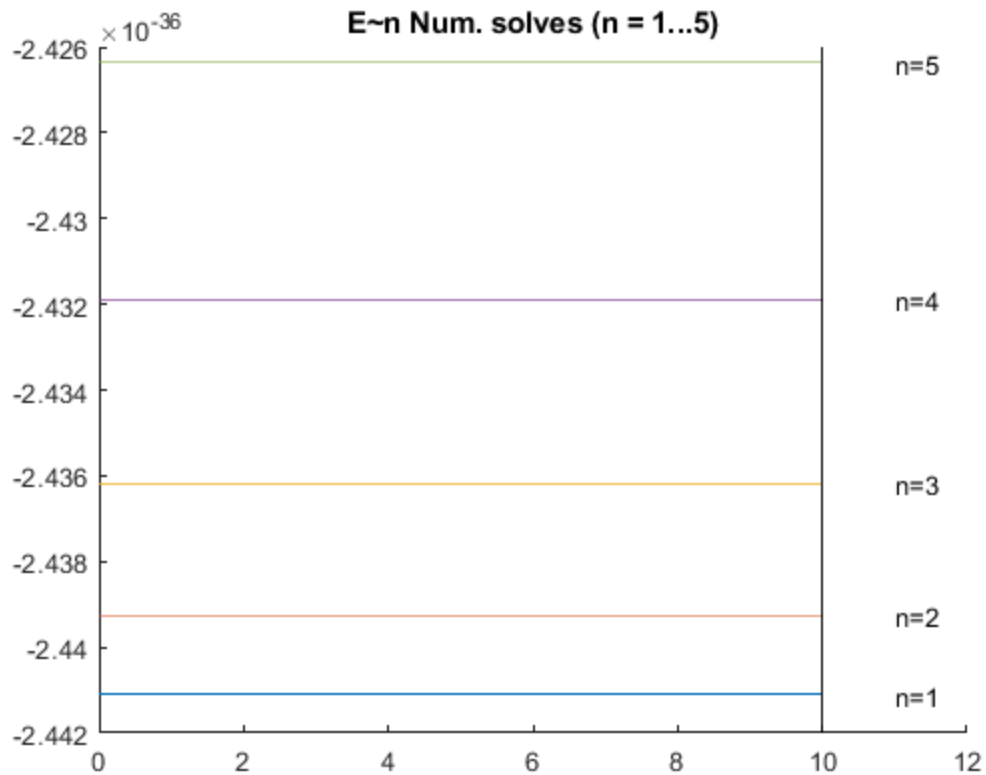
```

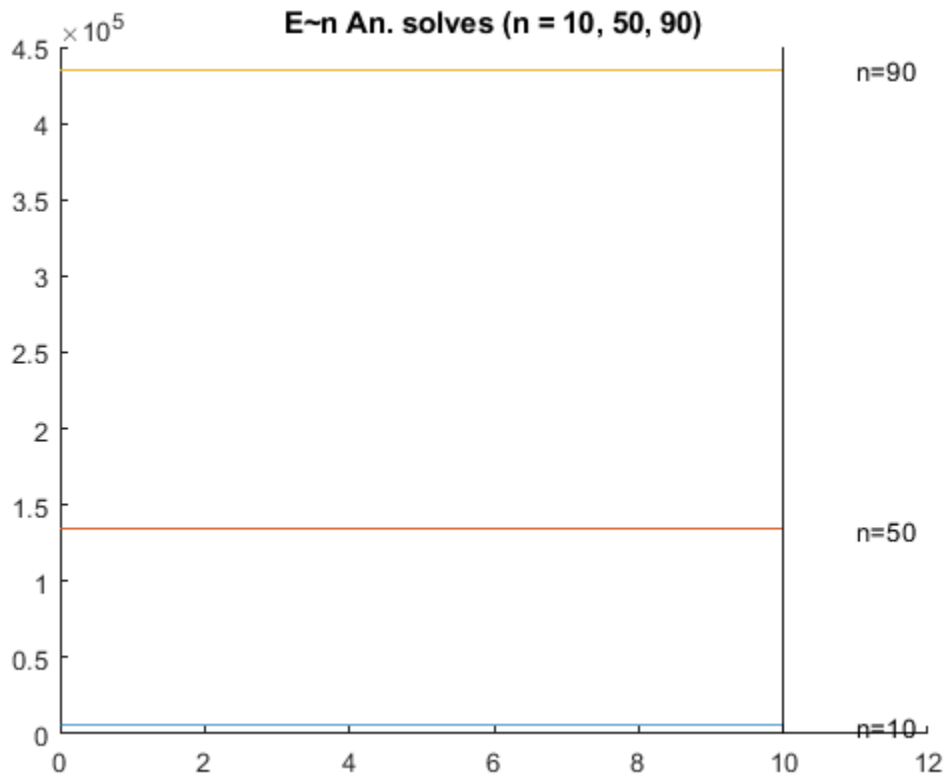
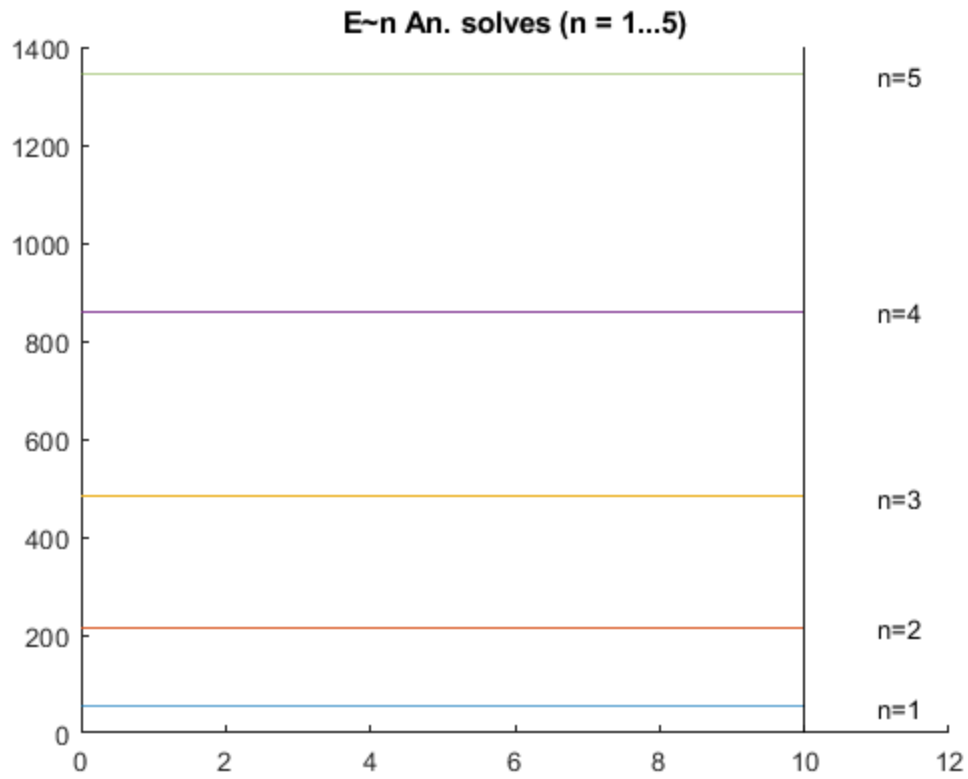
        xlim([0 12]);
    end
    plot([10 10], get(gca, 'Ylim'), 'k');
    title('E~n Num. solves (n = 10, 50, 90)')
    hold off

    figure('Name', 'E~n An. solves (n = 1...5)')
    hold on
    for n = 1:5
        E = Energy(n, 10, 0.07);
        x = [0 10];
        y = [E E];
        text(11, E, strcat('n=', num2str(n)))
        plot(x, y)
        xlim([0 12]);
    end
    plot([10 10], get(gca, 'Ylim'), 'k');
    title('E~n An. solves (n = 1...5)')
    hold off

    figure('Name', 'E~n An. solves (n = 10, 50, 90)')
    hold on
    for n = [10 50 90]
        E = Energy(n, 10, 0.07);
        x = [0 10];
        y = [E E];
        text(11, E, strcat('n=', num2str(n)))
        plot(x, y)
        xlim([0 12]);
    end
    plot([10 10], get(gca, 'Ylim'), 'k');
    title('E~n An. solves (n = 10, 50, 90)')
    hold off

```







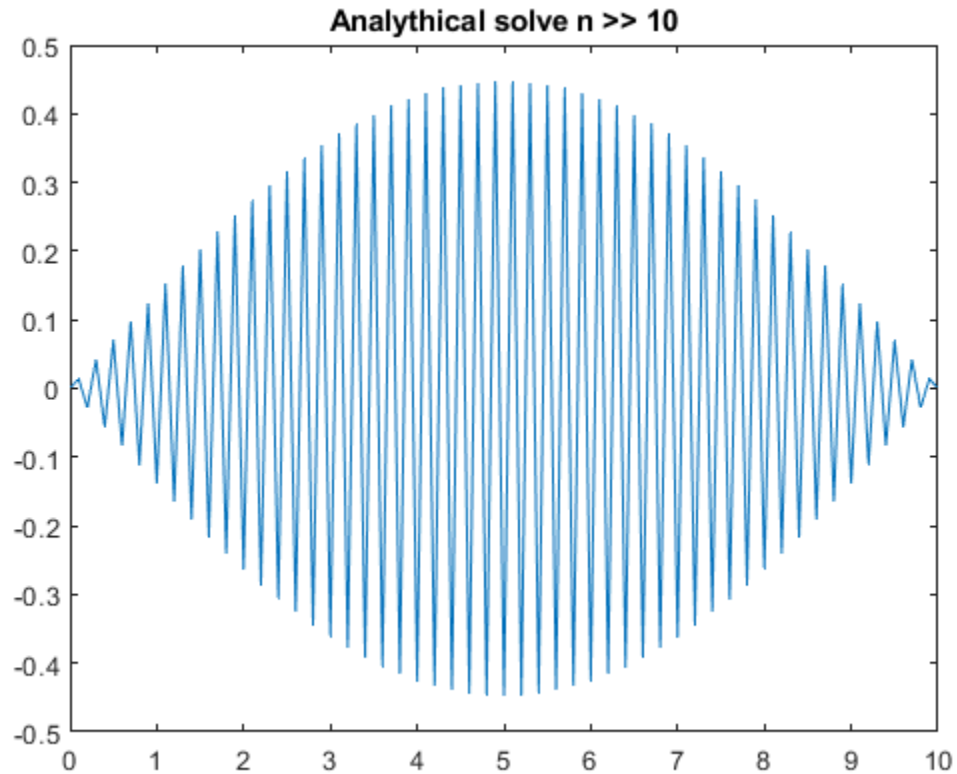
---

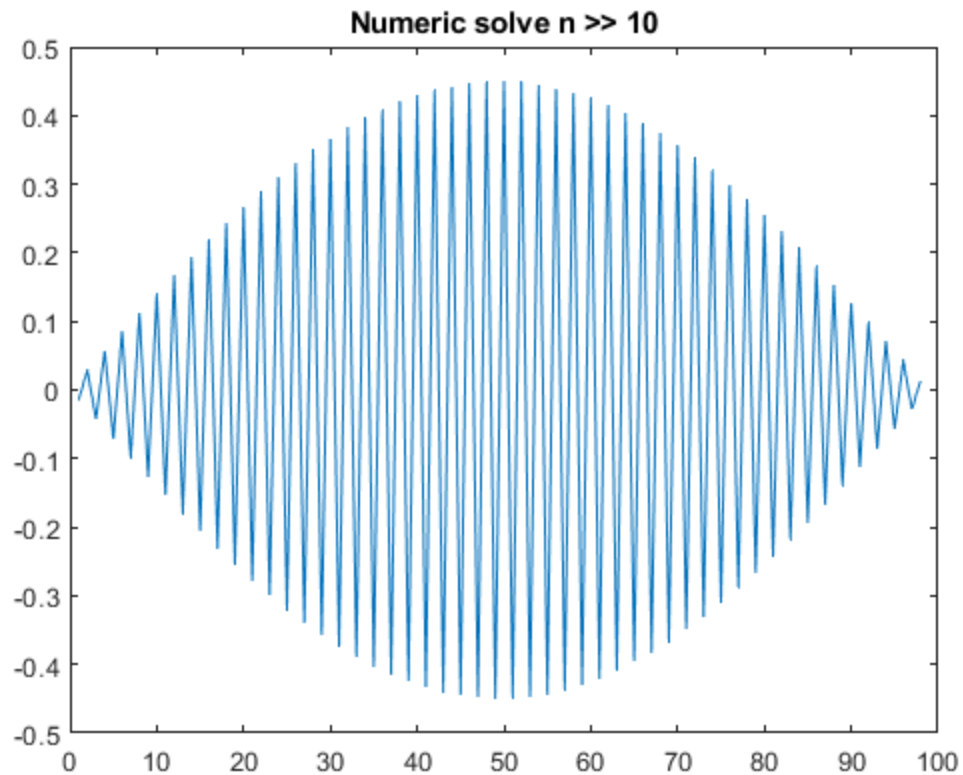
## Ex. 4 An. and Num. solves for $n \gg 10$

In ex.4 we need the same thing we had in ex.1 but for  $n \gg 10$  (for example, the highest  $n$  we had in task)

```
figure('Name', 'Analythical solve n >> 10')
L = 10;
x = 0:0.1:L;
h = 1/10;
n = 99;
Psin = sqrt(2 / L) * (sin(pi * n * x / L));
plot(x, Psin)
title('Analythical solve n >> 10')

figure('Name', 'Numeric solve n >> 10')
plot(1:N, psi(:,1))
title('Numeric solve n >> 10')
```





## Ex. 5 (Advanced) $E_n \sim n$ by numeric solve

In ex.5 we need to find out dependence of numeric  $E_n$  from  $n$  by plotting.

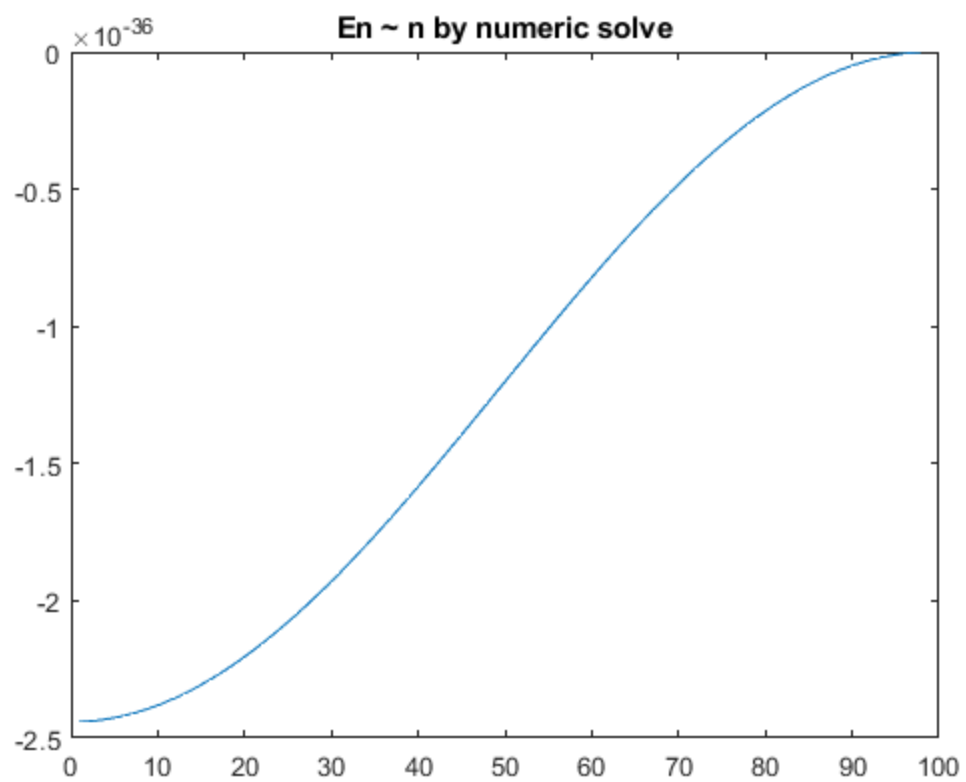
```
figure('Name', 'En ~ n by numeric solve')
n = 1:N;
E = hbar^2 * diag(D) / (h^2 * 2 * m0);
plot(n, E)
title('En ~ n by numeric solve')
```

```
datetime(clock)
```

```
ans =
```

```
datetime
```

```
27-Oct-2023 17:27:17
```



*Published with MATLAB® R2023a*