# гр . 221703 Вечорко Д . Вариант 13

## Задание 1

## a1)

In[234]:=

```
a = 0;
b = 1;
y' = y^2 + 0.7 * x^2 + 5 * y^2, y (0) = 0;
```

In[236]:=

```
h = 0.1;
f[x_, y_] := y^2 + 0.7 * Sin[2 x] ;
```

синус

In[238]:=

```
data = {{0, 0}};
```

In[239]:=

```
yb[n_] := data[[n]][[2]] + h * f[data[[n]][[1]], data[[n]][[2]]]
```

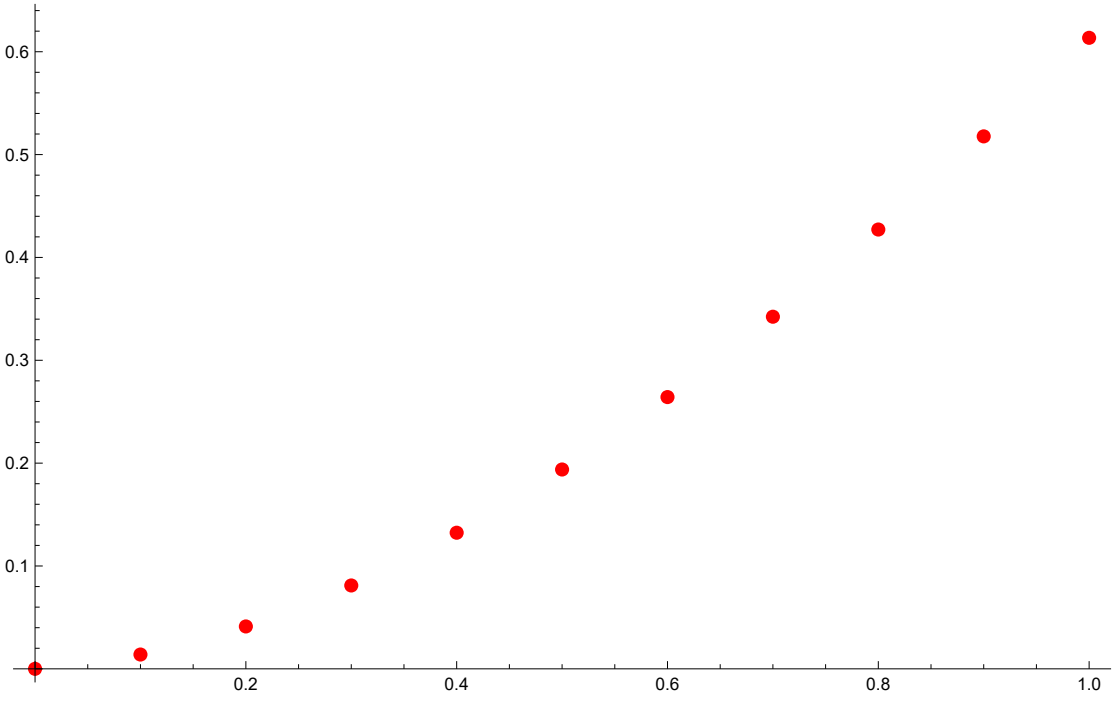
In[240]:=

```
For[i = 1, i ≤ b / h, i++,
 buff = {a + i * h, data[[i]][[2]] + h/2 * (f[a + i * h, data[[i]][[2]]] + f[a + i * h, yb[i]])};
 AppendTo[data, buff];]
data
Pl1 = ListPlot[data, PlotRange → Full, ImageSize → Large, PlotStyle → Red]
```

Out[241]=

```
{{0, 0}, {0.1, 0.0139069}, {0.2, 0.0412145},
 {0.3, 0.08106}, {0.4, 0.132338}, {0.5, 0.193816}, {0.6, 0.264225},
 {0.7, 0.342358}, {0.8, 0.427137}, {0.9, 0.517708}, {1., 0.613529}}
```

Out[242]=




## a2)

In[243]:=

```
h = 0.05
```

Out[243]=

```
0.05
```

In[244]:=

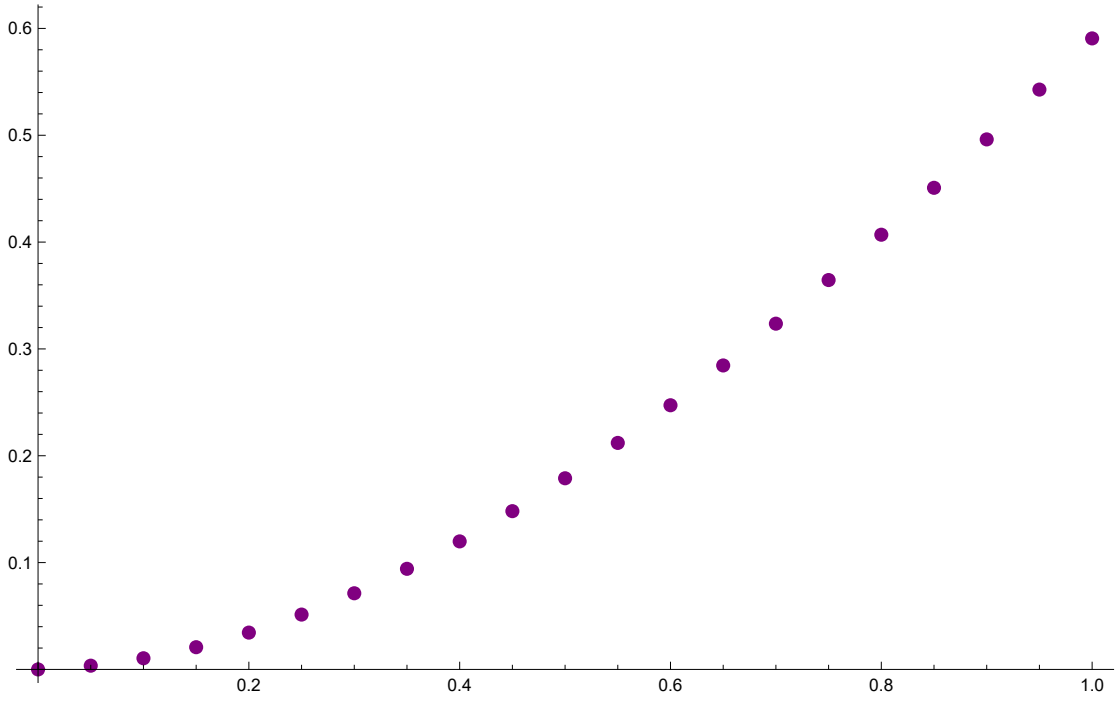
```
data = {{0, 0}};
For[i = 1, i ≤ b / h, i++,
 buff = {a + i * h, data[[i]][[2]] + h/2 * (f[a + i * h, data[[i]][[2]]] + f[a + i * h, yb[i]])};
 AppendTo[data, buff];]
data
Pl2 = ListPlot[data, PlotRange → Full, ImageSize → Large, PlotStyle → Purple]
```

цикл ДЛЯ | добавить в конец к | диаграмма разб… | отображаемы… | в по… | размер изоб… | крупный | стиль графика | фиолетовый

Out[246]=

```
{{0, 0}, {0.05, 0.00349417}, {0.1, 0.0104491}, {0.15, 0.0208026}, {0.2, 0.0344674},
 {0.25, 0.051335}, {0.3, 0.0712798}, {0.35, 0.0941628}, {0.4, 0.119835},
 {0.45, 0.148141}, {0.5, 0.178921}, {0.55, 0.212016}, {0.6, 0.247267},
 {0.65, 0.284522}, {0.7, 0.323633}, {0.75, 0.364465}, {0.8, 0.406892},
 {0.85, 0.450805}, {0.9, 0.496113}, {0.95, 0.542744}, {1., 0.590654}}
```

Out[247]=




In[248]:=

```
Clear[yb]
```

очистить

## б1)

In[249]:=

```
h = 0.1;
data = {{0, 0}};
x = a; y = data[[1]][[2]];
```

In[252]:=

```
For[k = 1, k ≤ b / h, k++,
 циклДЛЯ
  k1[x_, y_] := h * f[x, y];
  k2[x_, y_] := h * f[x + h/2, y + k1[x, y]/2];
  k3[x_, y_] := h * f[x + h/2, y + k2[x, y]/2];
  k4[x_, y_] := h * f[x + h, y + k3[x, y]];
  x = x + h; y = y + (k1[x, y] + 2 * k2[x, y] + 2 * k3[x, y] + k4[x, y]) / 6;
  buff = {x, y};
  AppendTo[data, buff];]
 добавить в конец к
```

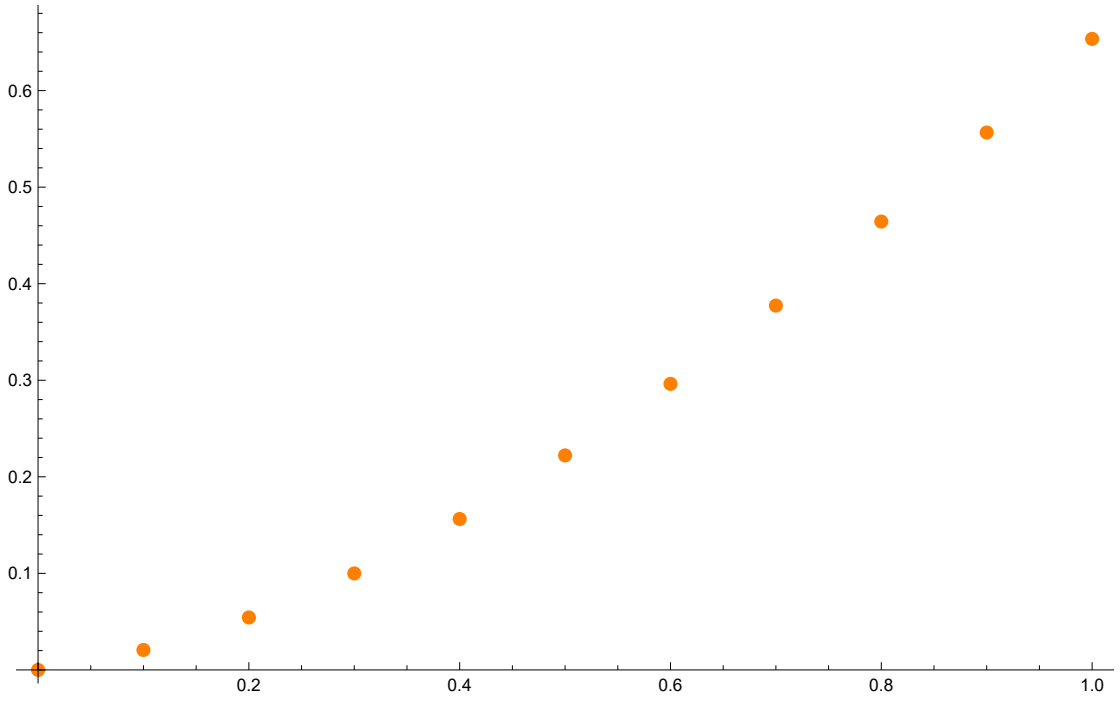
In[253]:=

```
data
Pl3 = ListPlot[data, PlotRange → Full, ImageSize → Large, PlotStyle → Orange]
      диаграмма разб··· отображаемы·· в по··· размер изоб··· крупный стиль графика оранжевы
```

Out[253]=

```
{{0, 0}, {0.1, 0.0206643}, {0.2, 0.0543107},
 {0.3, 0.0999286}, {0.4, 0.156317}, {0.5, 0.222188}, {0.6, 0.296257},
 {0.7, 0.377327}, {0.8, 0.464364}, {0.9, 0.556582}, {1., 0.653548}}
```

Out[254]=




## б2)

In[255]:=

```
h = 0.05;
data = {{0, 0}};
x = a; y = data[[1]][[2]];
```

In[258]:=

```
For[k = 1, k ≤ b / h, k++,
 k1[x_, y_] := h * f[x, y];
 k2[x_, y_] := h * f[x + h/2, y + k1[x, y]/2];
 k3[x_, y_] := h * f[x + h/2, y + k2[x, y]/2];
 k4[x_, y_] := h * f[x + h, y + k3[x, y]];
 x = x + h; y = y + (k1[x, y] + 2 * k2[x, y] + 2 * k3[x, y] + k4[x, y]) / 6;
 buff = {x, y};
 AppendTo[data, buff];]
```

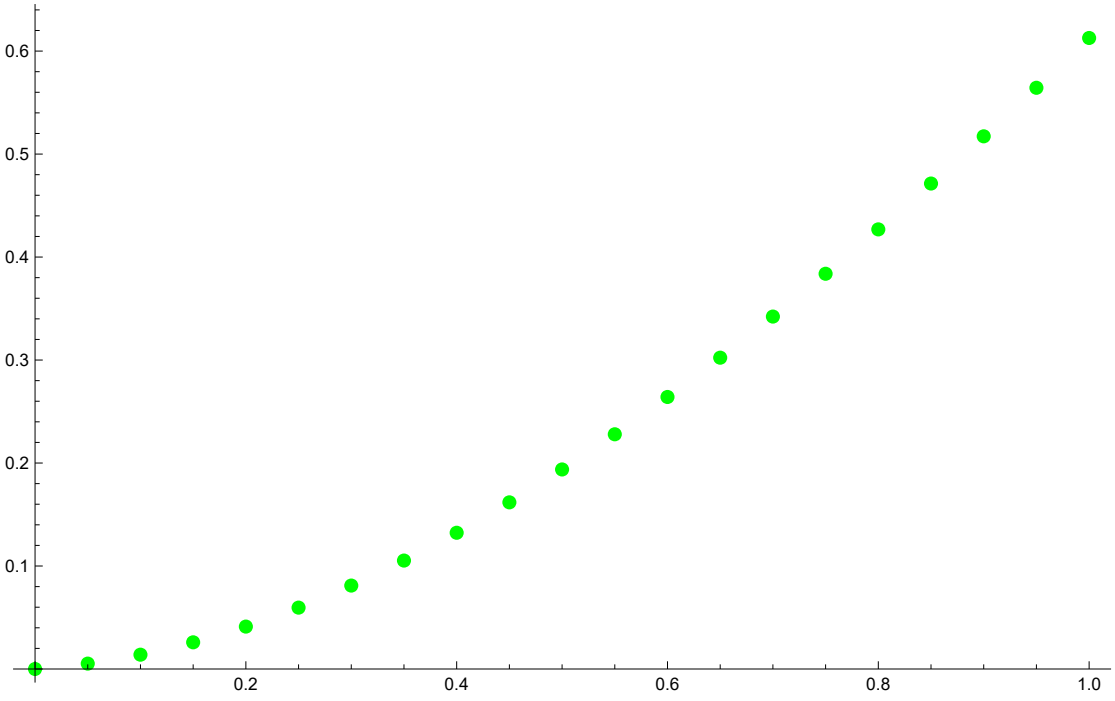
In[259]:=

```
data4 = data
ListPlot[data, ImageSize → Large, PlotRange → Full, PlotStyle → Green]
```

Out[259]=

```
{{0, 0}, {0.05, 0.00522855}, {0.1, 0.0138887}, {0.15, 0.025905}, {0.2, 0.0411788},
 {0.25, 0.0595923}, {0.3, 0.0810123}, {0.35, 0.105294}, {0.4, 0.132284},
 {0.45, 0.161823}, {0.5, 0.193752}, {0.55, 0.227909}, {0.6, 0.264137},
 {0.65, 0.302285}, {0.7, 0.34221}, {0.75, 0.383779}, {0.8, 0.426871},
 {0.85, 0.471386}, {0.9, 0.517237}, {0.95, 0.564364}, {1., 0.612732}}
```

Out[260]=




In[261]:=

```
Clear[h, x, y, k1, k2, k3, k4, buff, data]
```

## в)

In[262]:=

```
data = DSolve[{y'[x] == f[x, y[x]], y[0] == 0.8}, y[x], x];
```

решить дифференциальные уравнения

```
y1[x_] = y[x] /. Flatten[data]
```

уплостить

Out[263]=

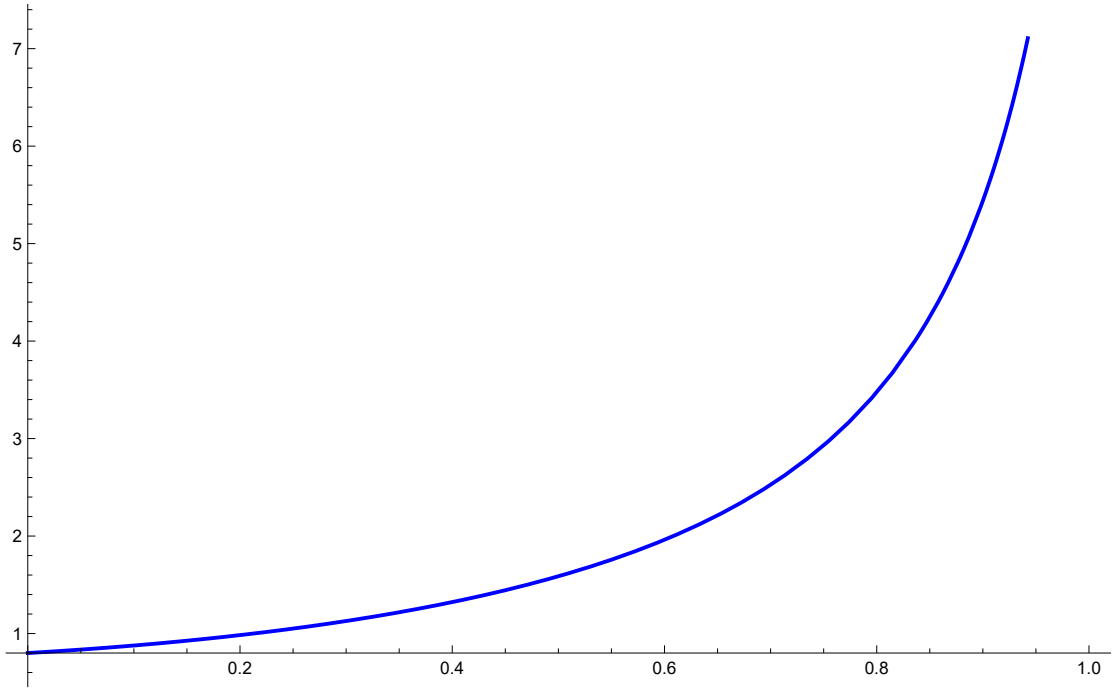
$$-\left(\left(1.\left(1.\,\text{MathieuCPrime}\left[0,-0.35,\frac{1}{2}\left(-\frac{\pi}{2}+2.\,x\right)\right]-19.29\,\text{MathieuSPrime}\left[0,-0.35,\frac{1}{2}\left(-\frac{\pi}{2}+2.\,x\right)\right]\right)\right)\Big/\left(1.\,\text{MathieuC}\left[0,-0.35,\frac{1}{2}\left(-\frac{\pi}{2}+2.\,x\right)\right]-19.29\,\text{MathieuS}\left[0,-0.35,\frac{1}{2}\left(-\frac{\pi}{2}+2.\,x\right)\right]\right)\right)$$

In[264]:=

```
Pl5 = Plot[y1[x], {x, 0, 1}, ImageSize → Large, PlotStyle → Blue]
```

график функции  размер изоб…  круп…  стиль графика  синий

Out[264]=




In[265]:=

```
data = NDSolve[{y'[x] == f[x, y[x]], y[0] == 0}, y[x], {x, a, b}]
```

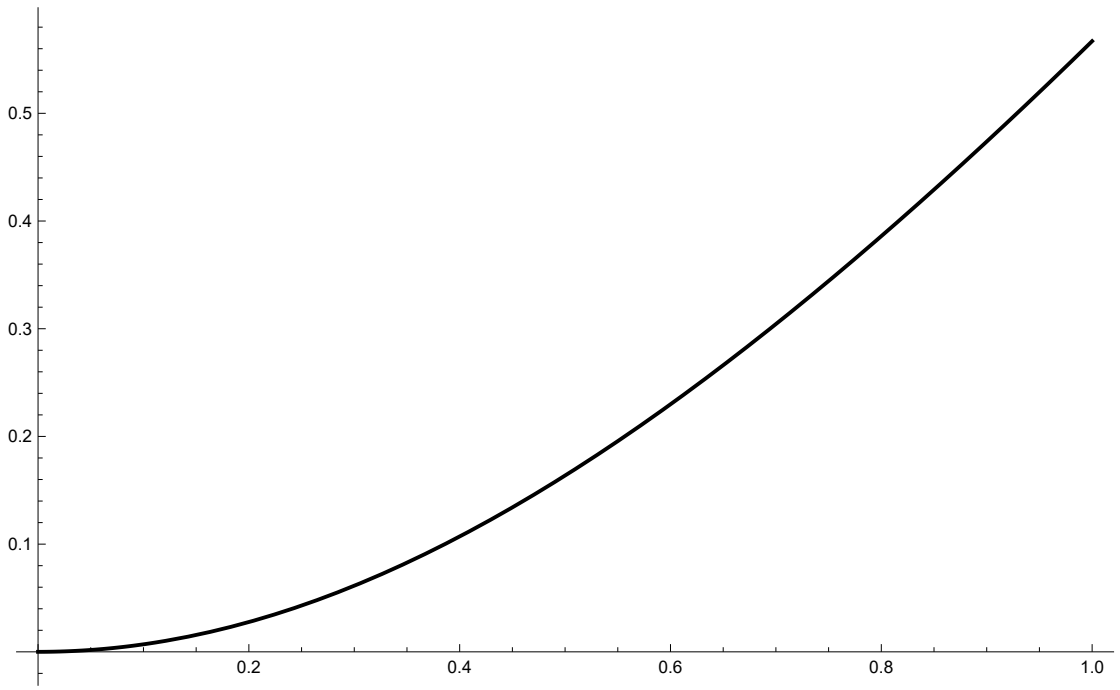
численно решить ДУ

Out[265]=

$$\left\{\left\{y[x] \to \text{InterpolatingFunction}\left[\text{Domain: } \{\{0.,\ 1.\}\} \text{ Output: scalar}\right][x]\right\}\right\}$$

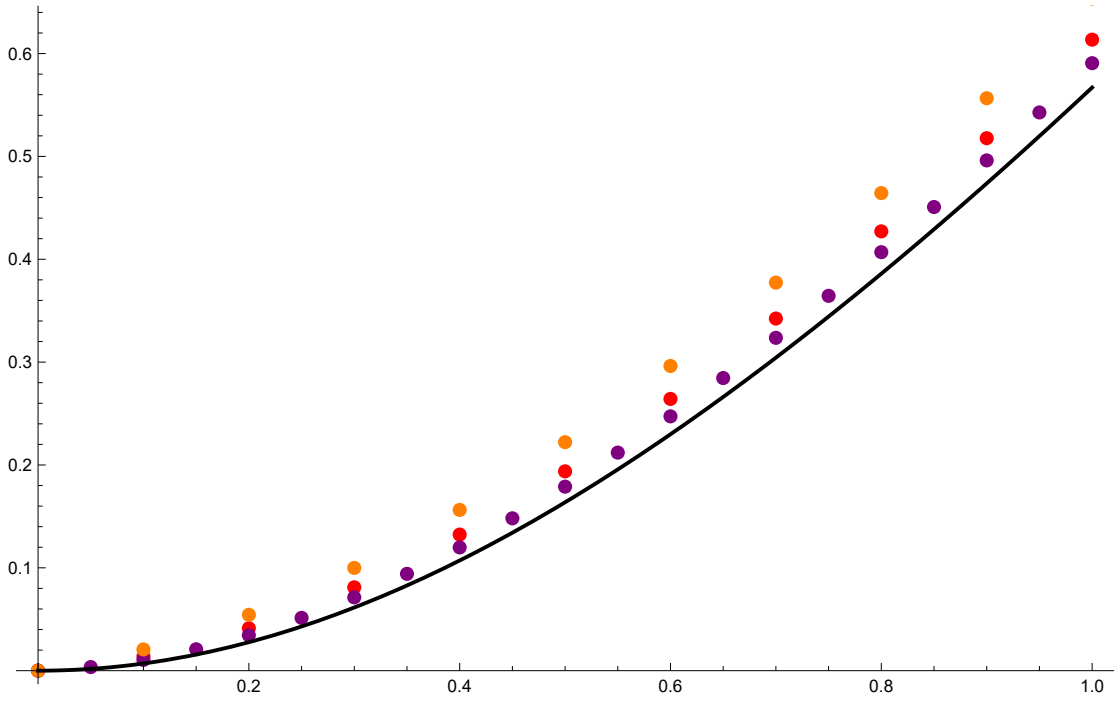
In[266]:=
```
Pl6 = Plot[Evaluate[y[x] /. data], {x, a, b}, ImageSize → Large, PlotStyle → Black]
```
гр··· вычислить размер изоб··· круп··· стиль графика чёрный

Out[266]=




In[267]:=
```
Show[Pl1, Pl2, Pl3, Pl5, Pl6, ImageSize → Large]
```
показать размер изоб··· крупный

Out[267]=




In[268]:=
```
Clear[Pl1, Pl2, Pl3, Pl5, Pl6, data4, data, y1, f]
```
очистить

С ростом шага сетки точность метода Эйлера - Коши уменьшилась, а

точность метода Рунге - Кутта 4 - го порядка увеличилась .

## Задание 2

$$\begin{cases} y' + 5y + z = 2, & y[0] == 1 \\ z' + 2y - z = \cos x, & z[0] == 1 \end{cases}$$

In[269]:=

```
a = 0; b = 1;
fy[x_, y_, z_] := 2 - 5 * y - z;
fz[x_, y_, z_] := Cos[x] - 2 * y + z;
                  |косинус
x0 = 0;
y0 = 1;
z0 = 1;
```

### a1)

In[273]:=

```
h = 0.1;
```

In[274]:=

```
datay = {{x0, y0}};
dataz = {{x0, z0}};
```

In[276]:=

```
For[i = 0; x1 = x0; y1 = y0; z1 = z0, i < b / h, i++,
|цикл ДЛЯ
  y1 = y1 + h * fy[x1, y1, z1];
  z1 = z1 + h * fz[x1, y1, z1];
  x1 = x1 + h;
  AppendTo[datay, {x1, y1}];
  |добавить в конец к
  AppendTo[dataz, {x1, z1}]];
  |добавить в конец к
datay
dataz
```

Out[277]=

```
{{0, 1}, {0.1, 0.6}, {0.2, 0.392}, {0.3, 0.27509},
 {0.4, 0.200245}, {0.5, 0.143544}, {0.6, 0.0931962}, {0.7, 0.0432527},
 {0.8, -0.00944195}, {0.9, -0.0667333}, {1., -0.129882}}
```

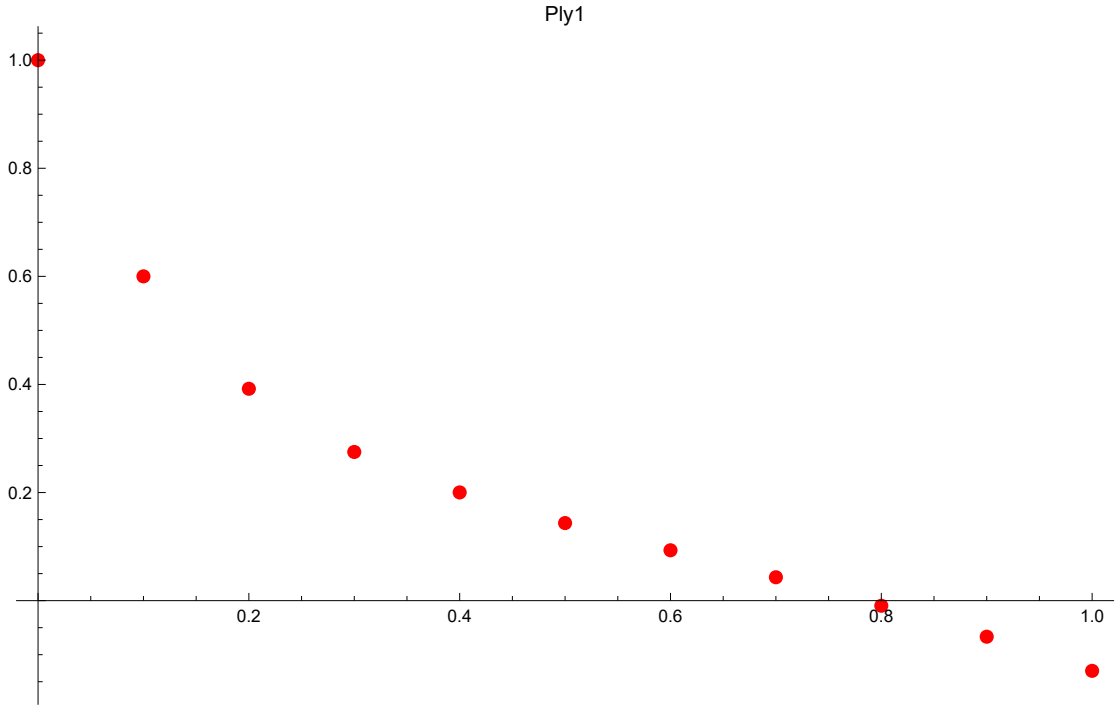
Out[278]=

```
{{0, 1}, {0.1, 1.08}, {0.2, 1.2091}, {0.3, 1.373}, {0.4, 1.56578}, {0.5, 1.78576},
 {0.6, 2.03345}, {0.7, 2.31068}, {0.8, 2.62012}, {0.9, 2.96515}, {1., 3.34981}}
```

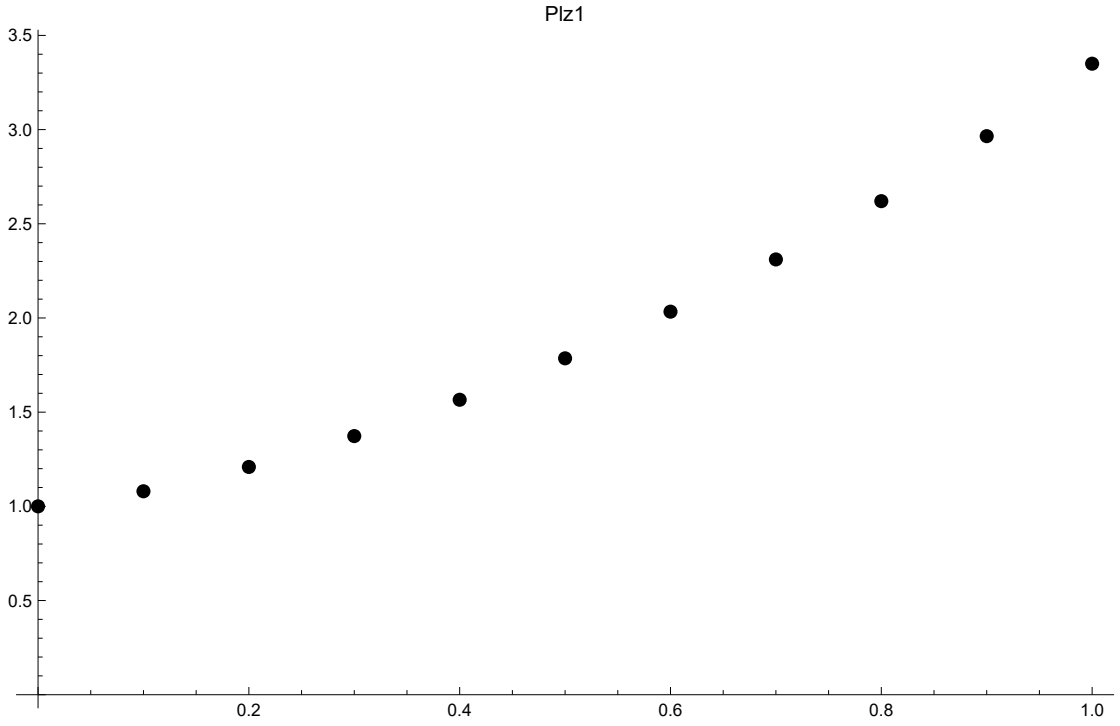
In[279]:=

```
Ply1 = ListPlot[datay, ImageSize → Large, PlotStyle → Red, PlotLabel → "Ply1"]
Plz1 = ListPlot[dataz, ImageSize → Large, PlotStyle → Black, PlotLabel → "Plz1"]
```

Out[279]=




Out[280]=




## a2)

In[281]:=

```
h = 0.05;
```

In[282]:=
```
datay = {{x0, y0}};
dataz = {{x0, z0}};
```

In[284]:=
```
For[i = 0; x1 = x0; y1 = y0; z1 = z0, i < b / h, i++,
 цикл ДЛЯ
  y1 = y1 + h * fy[x1, y1, z1];
  z1 = z1 + h * fz[x1, y1, z1];
  x1 = x1 + h;
  AppendTo[datay, {x1, y1}];
  добавить в конец к
  AppendTo[dataz, {x1, z1}]];
  добавить в конец к
datay
dataz
```

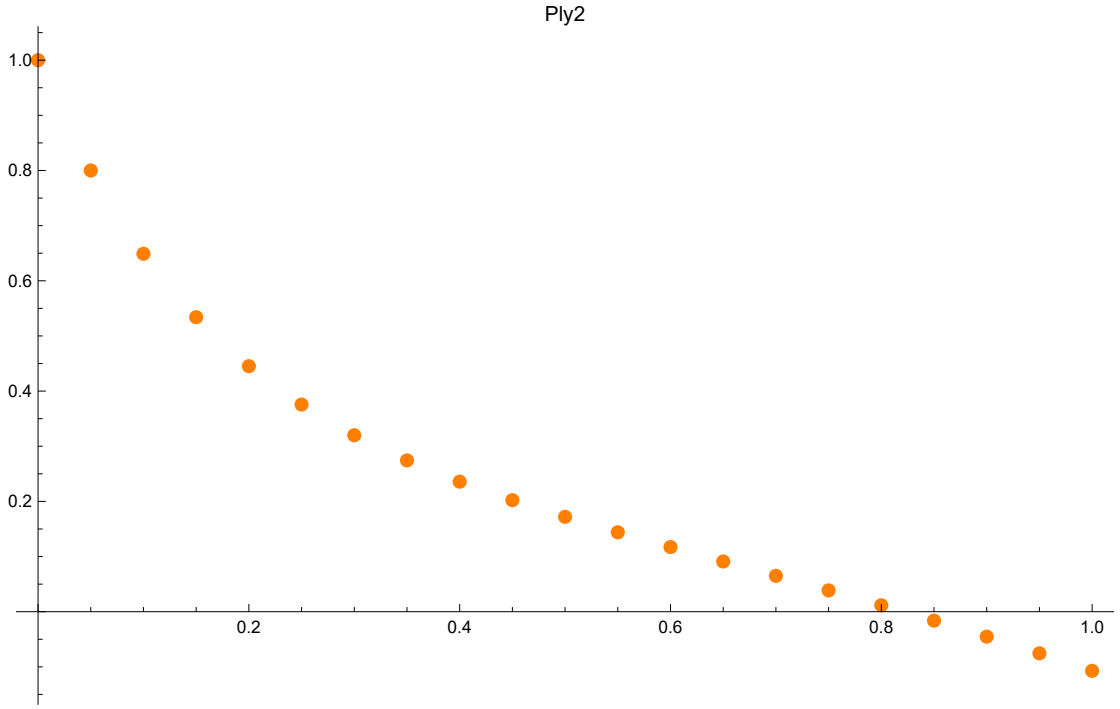
Out[285]=
```
{{0, 1}, {0.05, 0.8}, {0.1, 0.649}, {0.15, 0.533948}, {0.2, 0.445201},
 {0.25, 0.375632}, {0.3, 0.31997}, {0.35, 0.274313}, {0.4, 0.235771},
 {0.45, 0.202196}, {0.5, 0.171992}, {0.55, 0.143965}, {0.6, 0.117219},
 {0.65, 0.0910763}, {0.7, 0.0650197}, {0.75, 0.0386477}, {0.8, 0.011644},
 {0.85, -0.0162469}, {0.9, -0.045237}, {0.95, -0.0755084}, {1., -0.107223}}
```

Out[286]=
```
{{0, 1}, {0.05, 1.02}, {0.1, 1.05604}, {0.15, 1.10519}, {0.2, 1.16537}, {0.25, 1.23508},
 {0.3, 1.31328}, {0.35, 1.39928}, {0.4, 1.49264}, {0.45, 1.59311}, {0.5, 1.70058},
 {0.55, 1.8151}, {0.6, 1.93675}, {0.65, 2.06575}, {0.7, 2.20234}, {0.75, 2.34684},
 {0.8, 2.4996}, {0.85, 2.66104}, {0.9, 2.83161}, {0.95, 3.01182}, {1., 3.20222}}
```

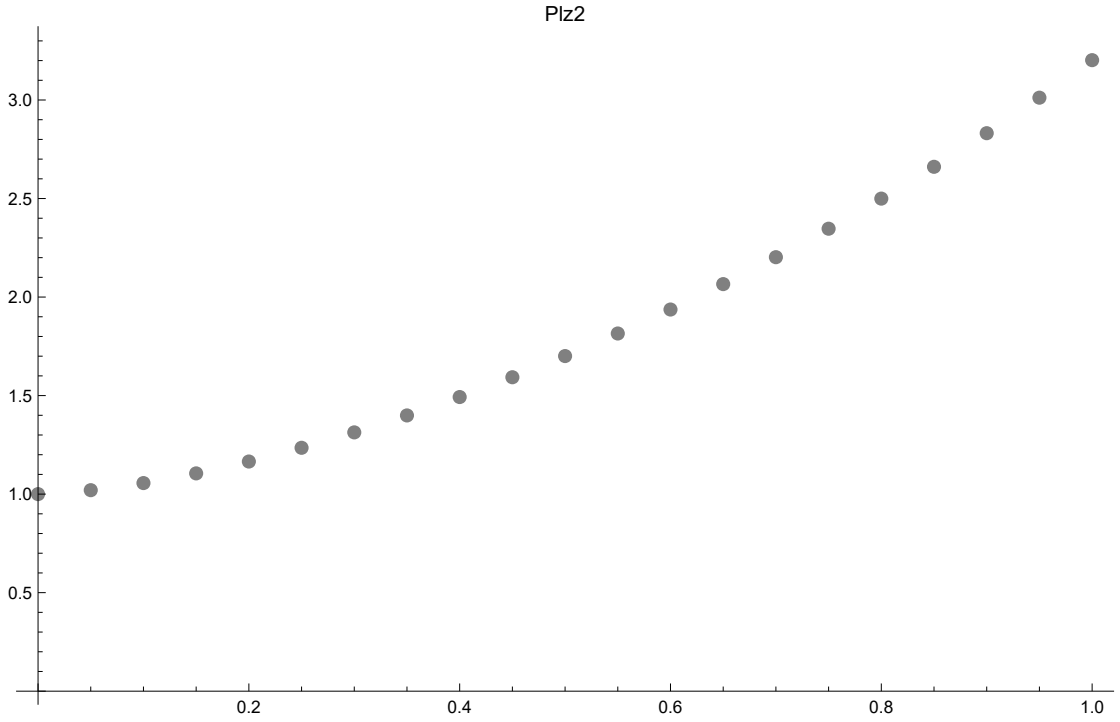
In[287]:=

```
Ply2 = ListPlot[datay, ImageSize → Large, PlotStyle → Orange, PlotLabel → "Ply2"]
Plz2 = ListPlot[dataz, ImageSize → Large, PlotStyle → Gray, PlotLabel → "Plz2"]
```

Out[287]=




Out[288]=

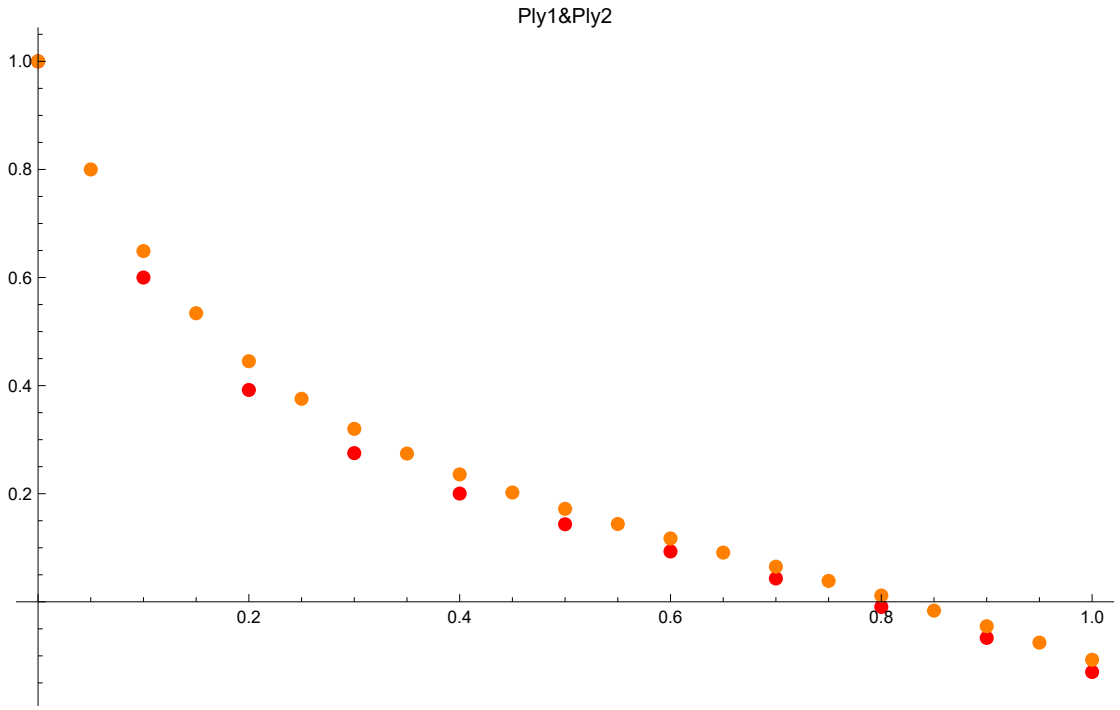


In[289]:=

```
Show[Ply1, Ply2, PlotLabel → "Ply1&Ply2"]
```

показать пометка графика

Out[289]=

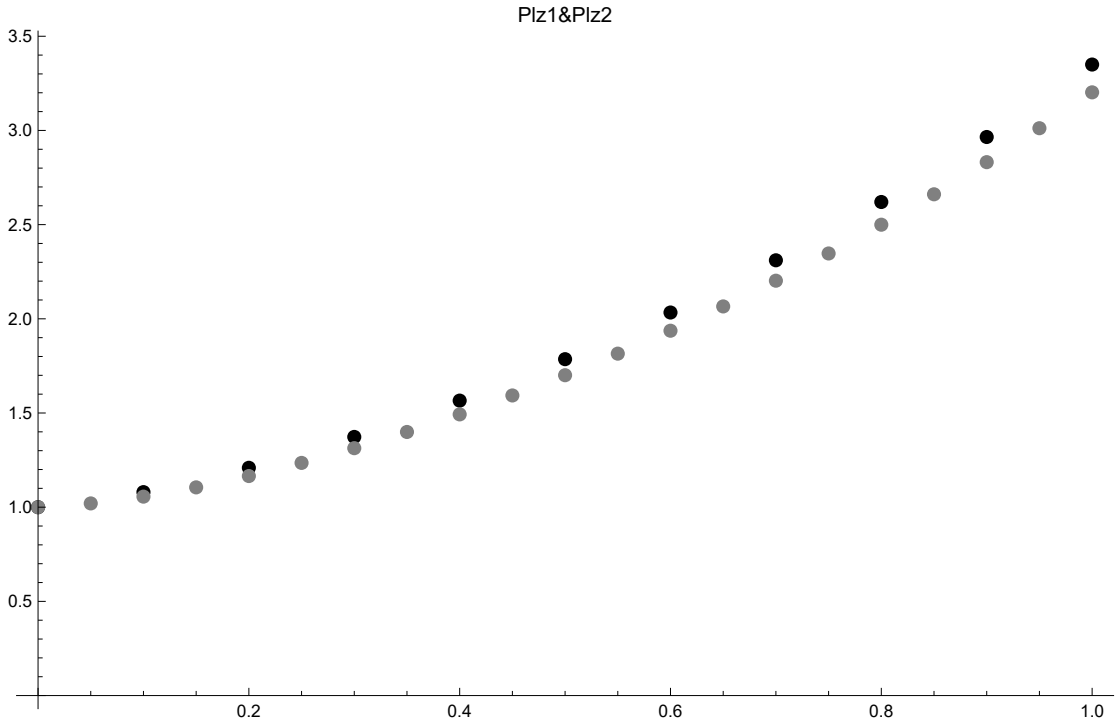



In[290]:=

```
Show[Plz1, Plz2, PlotLabel → "Plz1&Plz2"]
```

показать пометка графика

Out[290]=




In[291]:=

```
Clear[datay, dataz, y1, z1, x1, i, h, Ply1, Ply2, Plz1, Plz2]
```

очистить

## б1)

In[292]:=

```
h = 0.1;
datay = {{x0, y0}}; dataz = {{x0, y0}};
```

In[294]:=

```
For[rkx1 = x0; rky1 = y0; rkz1 = z0; i = 0, i < b / h, i++,
 цикл ДЛЯ
  k1 = h * fy[rkx1, rky1, rkz1];
  r1 = h * fz[rkx1, rky1, rkz1];
  k2 = h * fy[rkx1 + h / 2, rky1 + k1 / 2, rkz1 + r1 / 2];
  r2 = h * fz[rkx1 + h / 2, rky1 + k1 / 2, rkz1 + r1 / 2];
  k3 = h * fy[rkx1 + h / 2, rky1 + k2 / 2, rkz1 + r2 / 2];
  r3 = h * fz[rkx1 + h / 2, rky1 + k2 / 2, rkz1 + r2 / 2];
  k4 = h * fy[rkx1 + h, rky1 + k3, rkz1 + r3];
  r4 = h * fz[rkx1 + h, rky1 + k3, rkz1 + r3];
  rkx1 = rkx1 + h;
  rky1 = rky1 + (k1 + 2 * k2 + 2 * k3 + k4) / 6;
  rkz1 = rkz1 + (r1 + 2 * r2 + 2 * r3 + r4) / 6;
  AppendTo[datay, {rkx1, rky1}];
  добавить в конец к
  AppendTo[dataz, {rkx1, rkz1}]];
  добавить в конец к
datay
dataz
```

Out[295]=

```
{{0, 1}, {0.1, 0.684387}, {0.2, 0.487593}, {0.3, 0.359204},
 {0.4, 0.269458}, {0.5, 0.200712}, {0.6, 0.142425}, {0.7, 0.08821},
 {0.8, 0.0340842}, {0.9, -0.0225538}, {1., -0.0835374}}
```

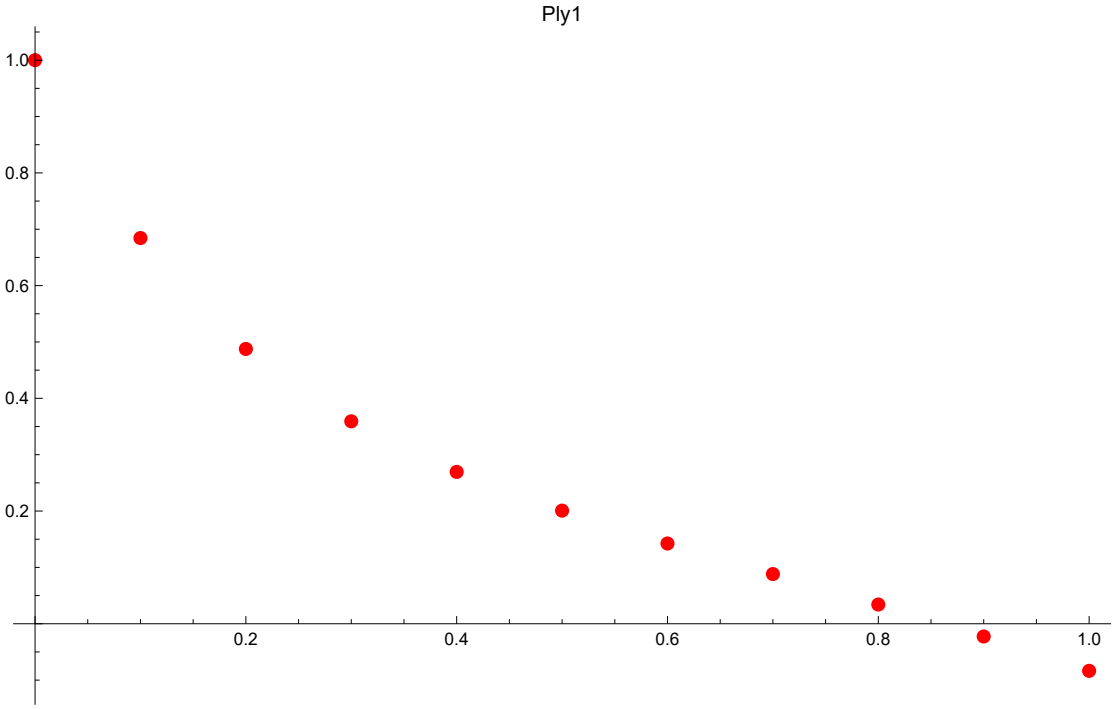
Out[296]=

```
{{0, 1}, {0.1, 1.03526}, {0.2, 1.12612}, {0.3, 1.25807}, {0.4, 1.42341}, {0.5, 1.61851},
 {0.6, 1.84233}, {0.7, 2.09552}, {0.8, 2.37991}, {0.9, 2.69828}, {1., 3.05424}}
```

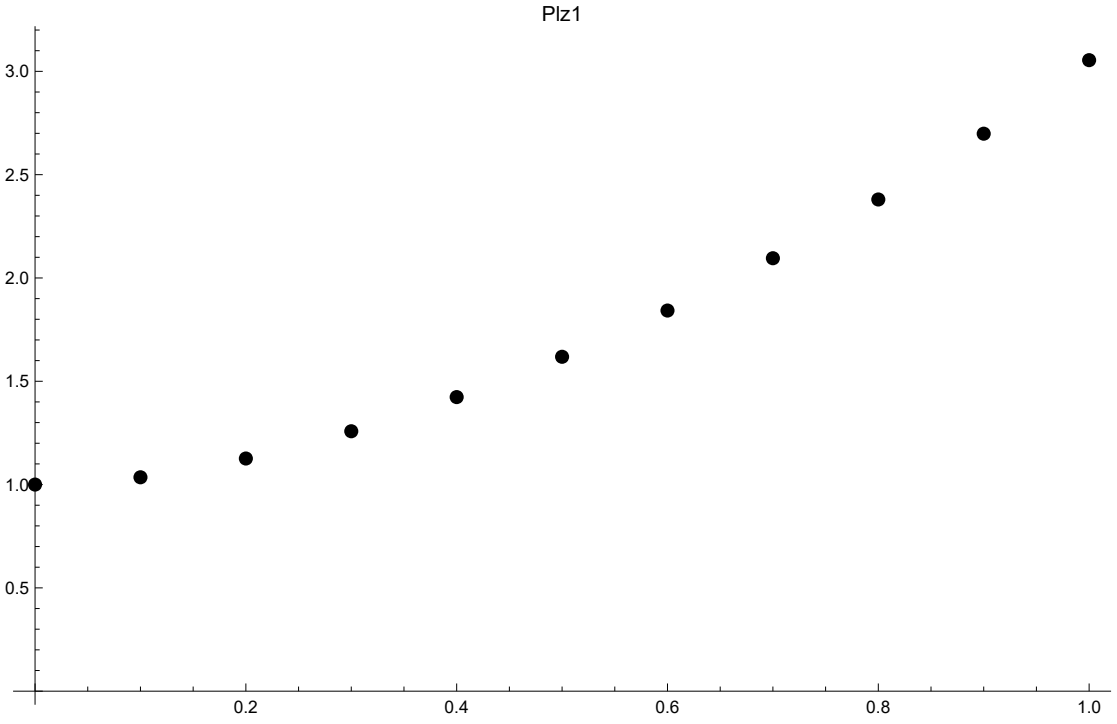
In[297]:=

```
Ply1 = ListPlot[datay, ImageSize → Large, PlotStyle → Red, PlotLabel → "Ply1"]
Plz1 = ListPlot[dataz, ImageSize → Large, PlotStyle → Black, PlotLabel → "Plz1"]
```

Out[297]=




Out[298]=



## б2)

In[299]:=
```
h = 0.05;
datay = {{x0, y0}}; dataz = {{x0, y0}};
```

In[301]:=
```
For[rkx1 = x0; rky1 = y0; rkz1 = z0; i = 0, i < b / h, i++,
 цикл ДЛЯ
  k1 = h * fy[rkx1, rky1, rkz1];
  r1 = h * fz[rkx1, rky1, rkz1];
  k2 = h * fy[rkx1 + h / 2, rky1 + k1 / 2, rkz1 + r1 / 2];
  r2 = h * fz[rkx1 + h / 2, rky1 + k1 / 2, rkz1 + r1 / 2];
  k3 = h * fy[rkx1 + h / 2, rky1 + k2 / 2, rkz1 + r2 / 2];
  r3 = h * fz[rkx1 + h / 2, rky1 + k2 / 2, rkz1 + r2 / 2];
  k4 = h * fy[rkx1 + h, rky1 + k3, rkz1 + r3];
  r4 = h * fz[rkx1 + h, rky1 + k3, rkz1 + r3];
  rkx1 = rkx1 + h;
  rky1 = rky1 + (k1 + 2 * k2 + 2 * k3 + k4) / 6;
  rkz1 = rkz1 + (r1 + 2 * r2 + 2 * r3 + r4) / 6;
  AppendTo[datay, {rkx1, rky1}];
  добавить в конец к
  AppendTo[dataz, {rkx1, rkz1}]];
  добавить в конец к
datay
dataz
```

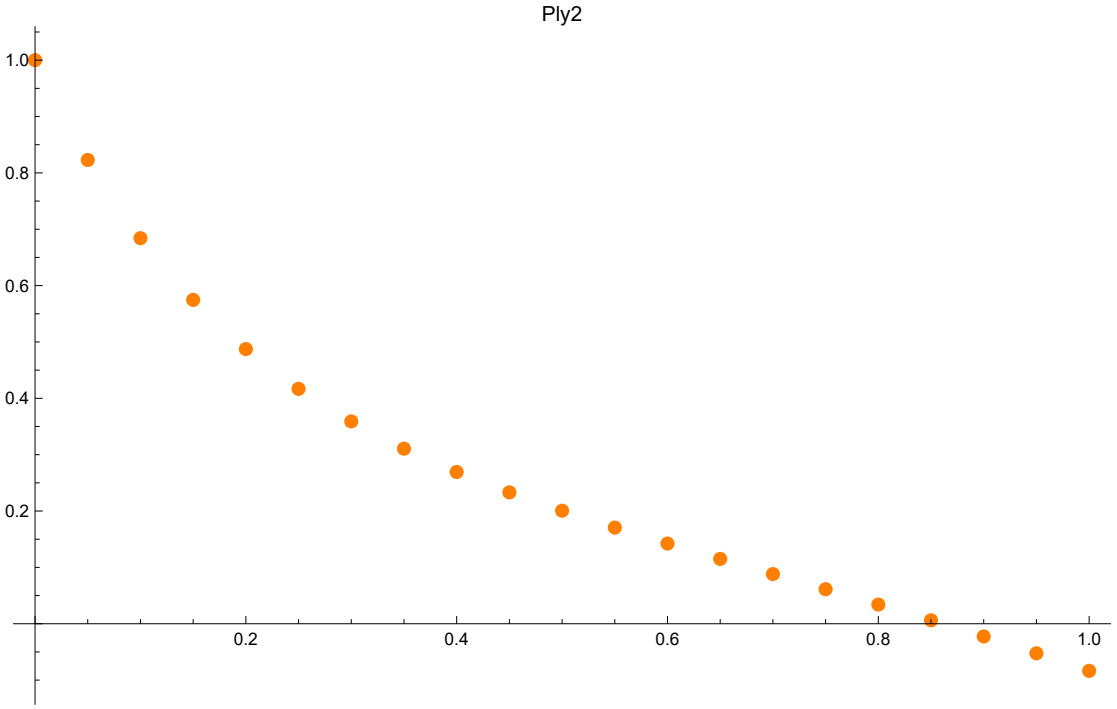
Out[302]=
```
{{0, 1}, {0.05, 0.822899}, {0.1, 0.684166}, {0.15, 0.574651}, {0.2, 0.487333},
 {0.25, 0.416822}, {0.3, 0.358976}, {0.35, 0.310612}, {0.4, 0.269279},
 {0.45, 0.233089}, {0.5, 0.20058}, {0.55, 0.170622}, {0.6, 0.142333},
 {0.65, 0.115022}, {0.7, 0.0881463}, {0.75, 0.0612698}, {0.8, 0.0340413},
 {0.85, 0.00617159}, {0.9, -0.0225824}, {0.95, -0.0524301}, {1., -0.0835565}}
```

Out[303]=
```
{{0, 1}, {0.05, 1.00936}, {0.1, 1.03519}, {0.15, 1.07477},
 {0.2, 1.12603}, {0.25, 1.18748}, {0.3, 1.258}, {0.35, 1.3368}, {0.4, 1.42335},
 {0.45, 1.5173}, {0.5, 1.61847}, {0.55, 1.72679}, {0.6, 1.84231},
 {0.65, 1.96515}, {0.7, 2.0955}, {0.75, 2.23365}, {0.8, 2.3799},
 {0.85, 2.53463}, {0.9, 2.69828}, {0.95, 2.87131}, {1., 3.05425}}
```

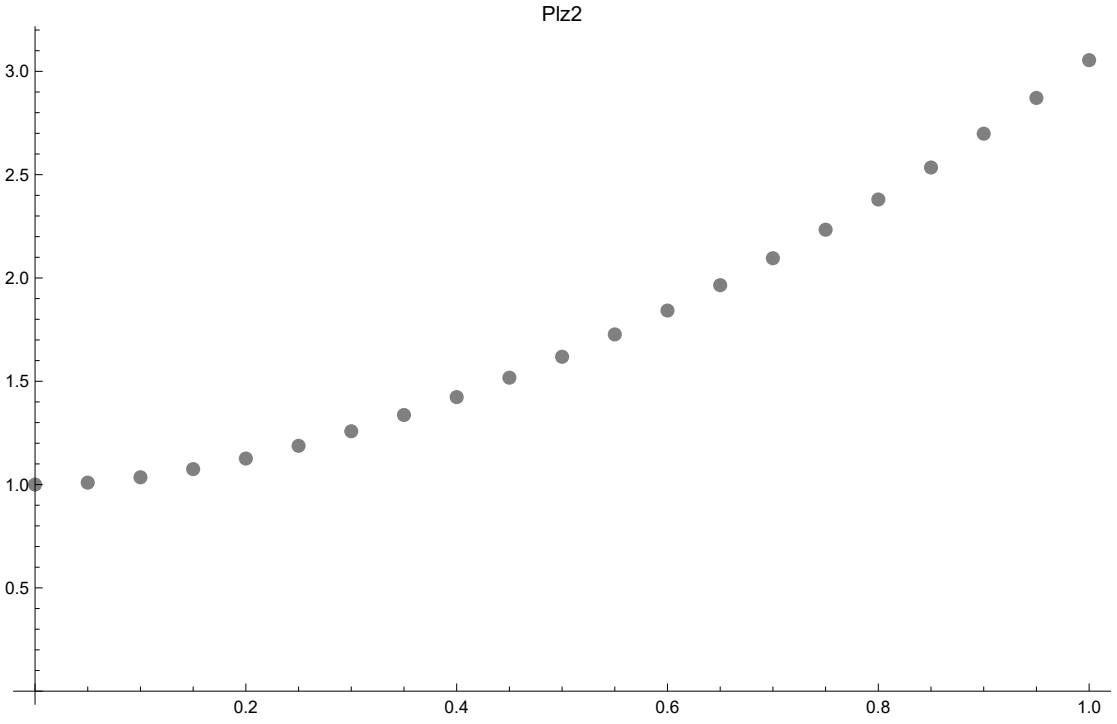
In[304]:=

```
Ply2 = ListPlot[datay, ImageSize → Large, PlotStyle → Orange, PlotLabel → "Ply2"]
Plz2 = ListPlot[dataz, ImageSize → Large, PlotStyle → Gray, PlotLabel → "Plz2"]
```

Out[304]=

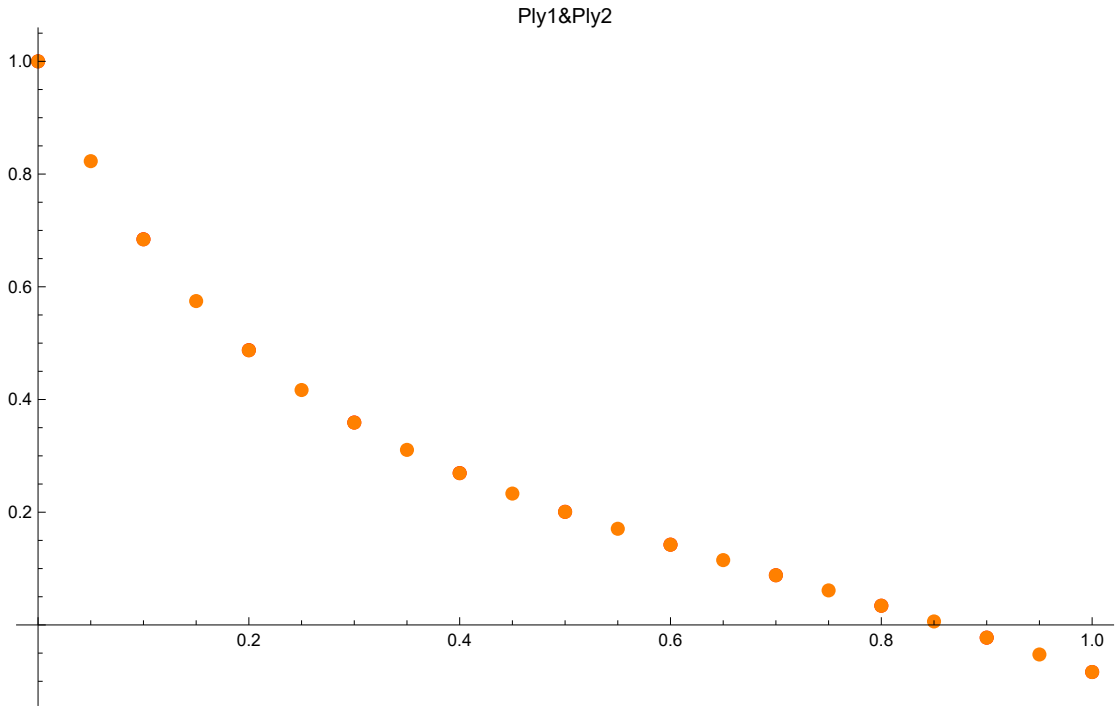



Out[305]=



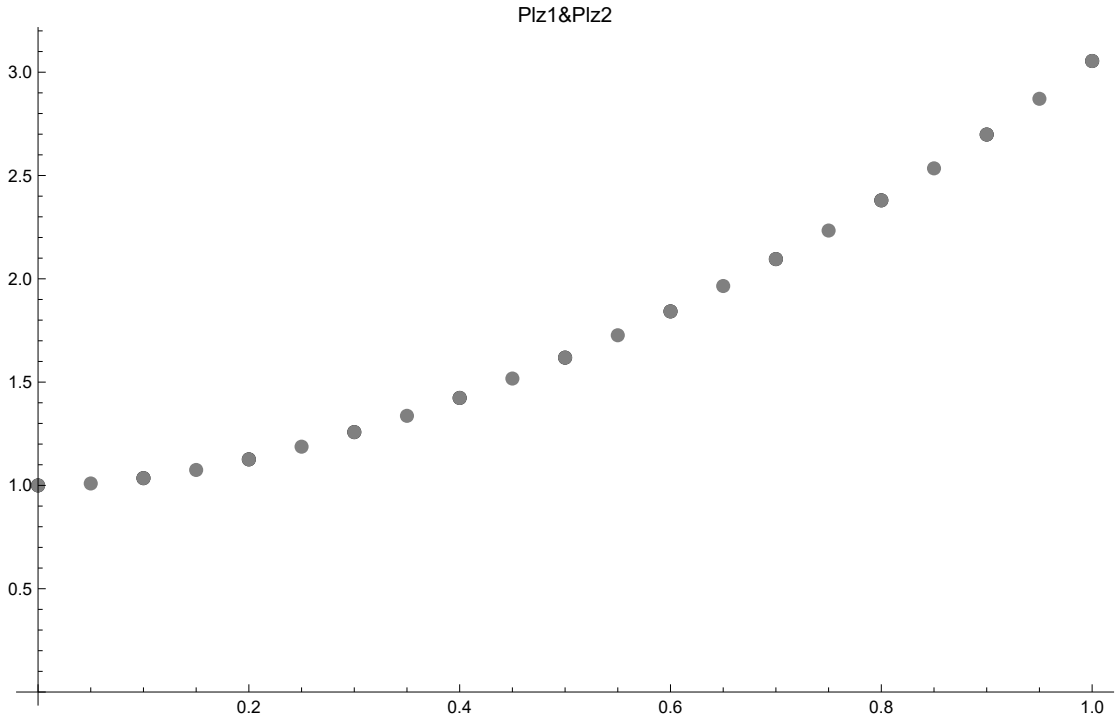
In[306]:=
```
Show[Ply1, Ply2, PlotLabel → "Ply1&Ply2"]
```
показать пометка графика

Out[306]=




In[307]:=
```
Show[Plz1, Plz2, PlotLabel → "Plz1&Plz2"]
```
показать пометка графика

Out[307]=




In[308]:=
```
Clear[Ply1, Ply2, Plz1, Plz2, datay, dataz,
 h, rkx1, rky1, rkz1, r1, r2, r3, r4, k1, k2, k3, k4, i]
```
очистить

## в)

In[309]:=
```
ds = DSolve[{y'[x] == fy[x, y[x], z[x]], y[x0] == y0,
    z'[x] == fz[x, y[x], z[x]], z[x0] == z0}, {y[x], z[x]}, x]
```
решить дифференциальные уравнения

Out[309]=
$$\left\{\left\{y[x] \to -\frac{1}{3080} e^{-2x-\sqrt{11}x-\left(-2+\sqrt{11}\right)x}\left(-880 e^{2\sqrt{11}x}-946 e^{\left(-2+\sqrt{11}\right)x}-381\sqrt{11}\, e^{\left(-2+\sqrt{11}\right)x}-946 e^{2\sqrt{11}x+\left(-2+\sqrt{11}\right)x}+381\sqrt{11}\, e^{2\sqrt{11}x+\left(-2+\sqrt{11}\right)x}-308 e^{2\sqrt{11}x}\text{Cos}[x]+154 e^{2\sqrt{11}x}\text{Sin}[x]\right),\right.\right.$$
$$\left.\left.z[x] \to \frac{1}{3080} e^{-2x-\sqrt{11}x-\left(-2+\sqrt{11}\right)x}\left(1760 e^{2\sqrt{11}x}+1353 e^{\left(-2+\sqrt{11}\right)x}-197\sqrt{11}\, e^{\left(-2+\sqrt{11}\right)x}+1353 e^{2\sqrt{11}x+\left(-2+\sqrt{11}\right)x}+197\sqrt{11}\, e^{2\sqrt{11}x+\left(-2+\sqrt{11}\right)x}-1386 e^{2\sqrt{11}x}\text{Cos}[x]+1078 e^{2\sqrt{11}x}\text{Sin}[x]\right)\right\}\right\}$$

In[310]:=
```
dsy[x_] = y[x] /. Flatten[ds]
```
уплостить

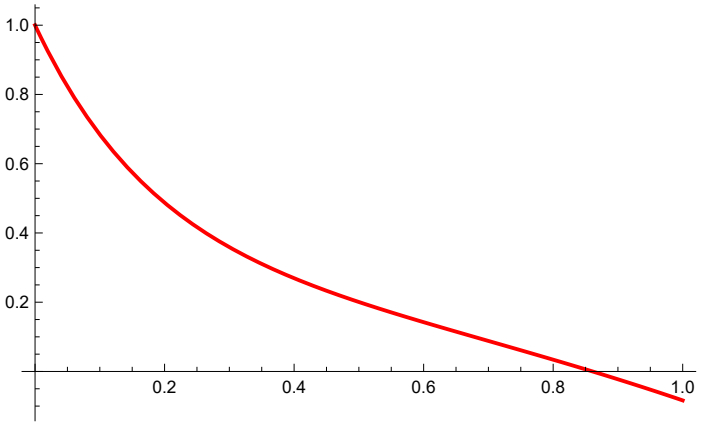
Out[310]=
$$-\frac{1}{3080} e^{-2x-\sqrt{11}x-\left(-2+\sqrt{11}\right)x}\left(-880 e^{2\sqrt{11}x}-946 e^{\left(-2+\sqrt{11}\right)x}-381\sqrt{11}\, e^{\left(-2+\sqrt{11}\right)x}-946 e^{2\sqrt{11}x+\left(-2+\sqrt{11}\right)x}+381\sqrt{11}\, e^{2\sqrt{11}x+\left(-2+\sqrt{11}\right)x}-308 e^{2\sqrt{11}x}\text{Cos}[x]+154 e^{2\sqrt{11}x}\text{Sin}[x]\right)$$

In[311]:=
```
dsz[x_] = z[x] /. Flatten[ds]
```
уплостить

Out[311]=
$$\frac{1}{3080} e^{-2x-\sqrt{11}x-\left(-2+\sqrt{11}\right)x}\left(1760 e^{2\sqrt{11}x}+1353 e^{\left(-2+\sqrt{11}\right)x}-197\sqrt{11}\, e^{\left(-2+\sqrt{11}\right)x}+1353 e^{2\sqrt{11}x+\left(-2+\sqrt{11}\right)x}+197\sqrt{11}\, e^{2\sqrt{11}x+\left(-2+\sqrt{11}\right)x}-1386 e^{2\sqrt{11}x}\text{Cos}[x]+1078 e^{2\sqrt{11}x}\text{Sin}[x]\right)$$

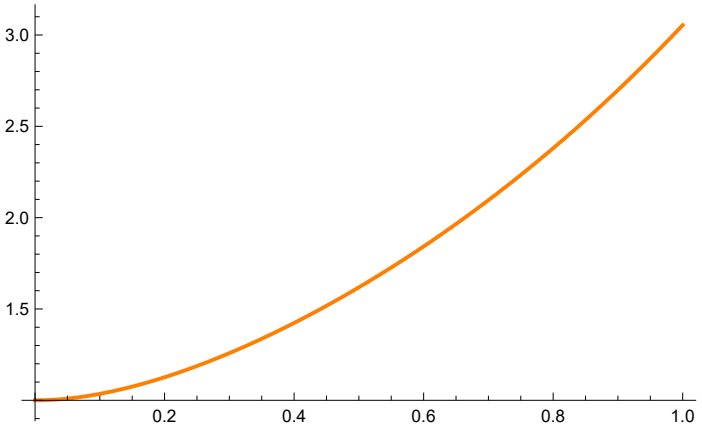
In[312]:=
```
Pl1 = Plot[dsy[x], {x, a, b}, PlotStyle → Red]
```
график функции  стиль графика  красн

Out[312]=



In[313]:=
```
Pl2 = Plot[dsz[x], {x, a, b}, PlotStyle → Orange]
```
график функции стиль графика оранжевы

Out[313]=




In[314]:=
```
nds = NDSolve[{y'[x] == fy[x, y[x], z[x]], y[x0] == y0,
    z'[x] == fz[x, y[x], z[x]], z[x0] == z0}, {y[x], z[x]}, {x, a, b}]
```
численно решить ДУ

Out[314]=

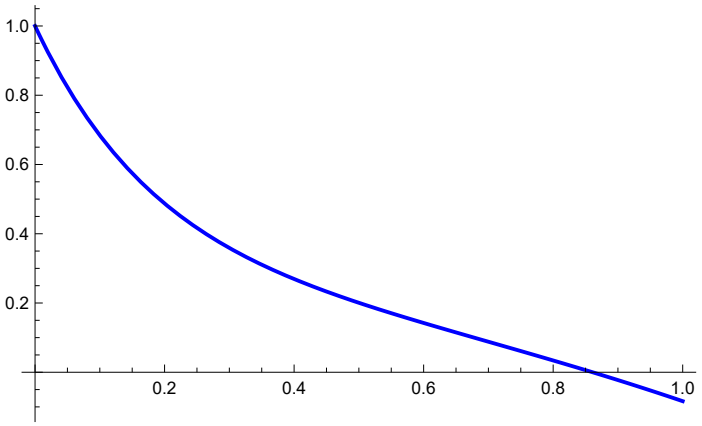
$$\left\{\left\{y[x] \to \text{InterpolatingFunction}\left[\{\{0.,\ 1.\}\},\ \text{Domain: } \{\{0.,\ 1.\}\}\ \text{Output: scalar}\right][x],\right.\right.$$

$$\left.\left.z[x] \to \text{InterpolatingFunction}\left[\{\{0.,\ 1.\}\},\ \text{Domain: } \{\{0.,\ 1.\}\}\ \text{Output: scalar}\right][x]\right\}\right\}$$

In[315]:=
```
dsny[x_] = y[x] /. Flatten[nds];
```
уплостить
```
dsnz[x_] = z[x] /. Flatten[nds];
```
уплостить

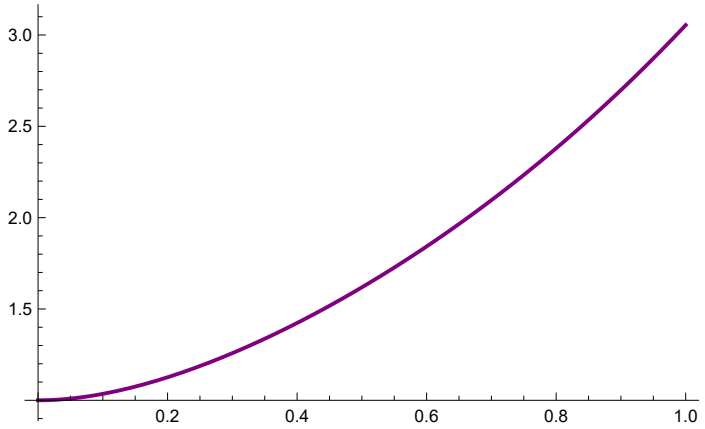
In[317]:=
```
Pl3 = Plot[dsny[x], {x, a, b}, PlotStyle → Blue]
```
график функции стиль графика синий

Out[317]=



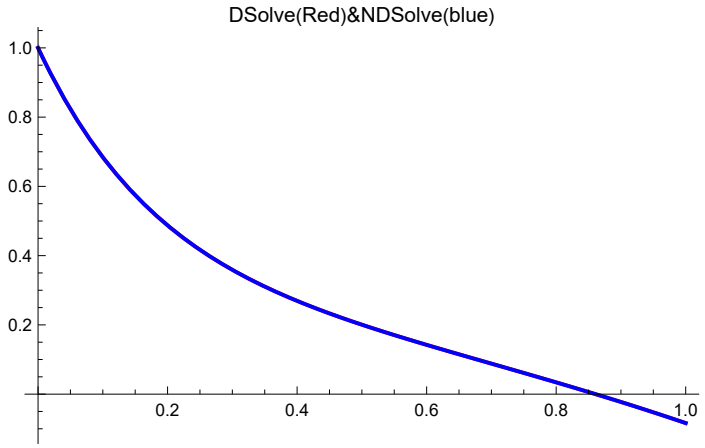
In[318]:=
```
Pl4 = Plot[dsnz[x], {x, a, b}, PlotStyle → Purple]
```
график функции  стиль графика  фиолетов

Out[318]=



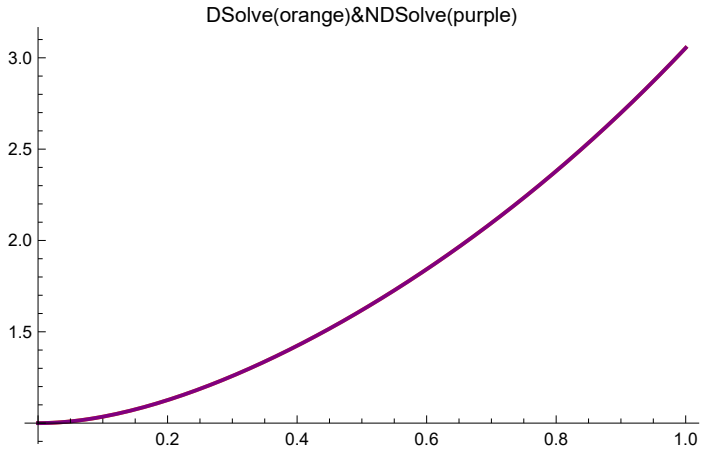

In[319]:=
```
Show[Pl1, Pl3, PlotLabel → "DSolve(Red)&NDSolve(blue)"]
```
показать  пометка граф⋯  решит⋯  кра⋯  численно решить ДУ

Out[319]=




In[320]:=
```
Show[Pl2, Pl4, PlotLabel → "DSolve(orange)&NDSolve(purple)"]
```
показать  пометка граф⋯  решить диффере⋯  численно решить ДУ

Out[320]=



In[321]:=
```
Clear[Pl1, Pl2, Pl3, Pl4, a, b, ds, nds, dsy, dsz, dsny, dsnz, fy, fz, x0, y0, z0]
```
очистить

Наибольшую точность показал метод Рунге - Кутта 4 - го порядка .