ODE HW 6.1, 6.2

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euler's method

ODE: $z' = x - 2z$, $z(0) = 1$, $h = 0.1$

k	x_k	z_k	$f(x_k, z_k)$	$f \cdot h$	z_{k+1}
0	0.0	1.0000	-2.0000	-0.2000	0.8000
1	0.1	0.8000	-1.5000	-0.1500	0.6500
2	0.2	0.6500	-1.1000	-0.1100	0.5400
3	0.3	0.5400	-0.7800	-0.0780	0.4620
4	0.4	0.4620	-0.5240	-0.0524	0.4096
5	0.5	0.4096	—	—	—

code:

```python
# eulers method for z' = x - 2z, z(0) = 1


x = 0.0
z = 1.0
h = 0.1

steps = 5

print(f"{'k':<5} {'x_k':<8} {'z_k':<8} {'f(x_k,z_k)':<12} {'f*h':<10} {'z_k+1':<8}") #table variables
print("-" * 60)

for k in range(steps):
    f = x - 2*z
    f_times_h = f*h
    next_z = z + f_times_h

    print(f"{k:<5} {x:<8.1f} {z:<8.4f} {f:<12.4f} {f_times_h:<10.4f} {next_z:<8.4f}")
```

```
19
20      x = x + h
21      z = next_z
22
23  print(f"{steps:<5} {x:<8.1f} {z:<8.4f}")
```

RK2 midpoint method

ODE: $z' = x - 2z$, $z(0) = 1$, $h = 0.1$

k	x_k	z_k	k_1	k_2	z_{k+1}
0	0.0	1.0000	-2.0000	-1.7500	0.8250
1	0.1	0.8250	-1.5500	-1.3450	0.6905
2	0.2	0.6905	-1.1810	-1.0129	0.5892
3	0.3	0.5892	-0.8784	-0.7406	0.5152
4	0.4	0.5152	-0.6304	-0.5174	0.4578
5	0.5	0.4578	—	—	—

code:

```
1  # RK2 Midpoint Method for z' = x - 2z, z(0) = 1, h = 0.1
2
3  x = 0.0
4  z = 1.0
5  h = 0.1
6  steps = 5
7
8  print(f"{'k':<5} {'x_k':<8} {'z_k':<10} {'k1':<10} {'k2':<10} {'z_k
       +1':<10}") #table variables
9  print("-" * 60)
10
11  for k in range(steps):
12      k1 = x - 2*z
13      k2 = (x + h/2) - 2*(z + k1*h/2)
14      z_next = z + k2*h
15
16      print(f"{k:<5} {x:<8.1f} {z:<10.4f} {k1:<10.4f} {k2:<10.4f} {
           z_next:<10.4f}")
17
18      x = x + h
19      z = z_next
20
21  print(f"{steps:<5} {x:<8.1f} {z:<10.4f}")
```

made in python 3.13.7