**Standard function**

**Characteristics of 23 standard test functions**

| **Number** | **Name** | **The boundary range of the search space** | **Function dimension** | **Functional category** | **Optimal solution** |
| --- | --- | --- | --- | --- | --- |
| F1 | Sphere | [-100,100] | 30 | U | 0 |
| F2 | Schwefel’s problem 2.22 | [-100,10] | 30 | U | 0 |
| F3 | Schwefel’s problem 1.2 | [-100,100] | 30 | U | 0 |
| F4 | Schwefel’s problem 2.21 | [-100,100] | 30 | U | 0 |
| F5 | Rosenbrock | [-30,30] | 30 | U | 0 |
| F6 | Step | [-100,100] | 30 | U | 0 |
| F7 | Noise | [-128,128] | 30 | M | 0 |
| F8 | Generalized Schwefel’s problem | [-500,500] | 30 | M | -12569.5 |
| F9 | Rastrigin | [-5.12,5.12] | 30 | M | 0 |
| F10 | Ackley | [-32,32] | 30 | M | 0 |
| F11 | Griewan | [-600,600] | 30 | M | 0 |
| F12 | Generalized Penalized Function 1 | [-50,50] | 30 | M | 0 |
| F13 | Generalized Penalized Function 2 | [-50,50] | 30 | M | 0 |
| F14 | Shekel’s Foxholes function | [-65,65] | 2 | M | 1 |
| F15 | Kowalik’s function | [-5,5] | 4 | M | 0.0003 |
| F16 | Six-hump camel back | [-5,5] | 2 | M | -1.0316 |
| F17 | Branin | [-5,5] | 2 | M | 0.398 |
| F18 | Goldstein-Price function | [-2,2] | 2 | M | 3 |
| F19 | Hartman 1 | [1,3] | 3 | M | -3.86 |
| F20 | Hartman 2 | [0,1] | 6 | M | -3.32 |
| F21 | Shekel 1 | [0,10] | 4 | M | -10.1532 |
| F22 | Shekel 2 | [0,10] | 4 | M | -10.4028 |
| F23 | Shekel 3 | [0,10] | 4 | M | -10.5363 |

**Formulas for 23 standard test functions**

| **Number** | **Functional expression** |
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