

Computer algebra independent integration tests

4-Trig-functions/4.6-Cosecant/4.6.0-a-csc-^m-b-trg-ⁿ

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Chapter 1

Introduction

This report gives the result of running the computer algebra independent integration problems. The listing of the problems are maintained by and can be downloaded from <https://rulebasedintegration.org>

The number of integrals in this report is [70]. This is test number [127].

1.1 Listing of CAS systems tested

The following systems were tested at this time.

1. Mathematica 12.1 (64 bit) on windows 10.
2. Rubi 4.16.1 in Mathematica 12 on windows 10.
3. Maple 2020 (64 bit) on windows 10.
4. Maxima 5.43 on Linux. (via sagemath 8.9)
5. Fricas 1.3.6 on Linux (via sagemath 9.0)
6. Sympy 1.5 under Python 3.7.3 using Anaconda distribution.
7. Giac/Xcas 1.5 on Linux. (via sagemath 8.9)

Maxima, Fricas and Giac/Xcas were called from inside SageMath. This was done using SageMath integrate command by changing the name of the algorithm to use the different CAS systems.

Sympy was called directly using Python.

1.2 Results

Important note: A number of problems in this test suite have no antiderivative in closed form. This means the antiderivative of these integrals can not be expressed in terms of elementary, special functions or Hypergeometric2F1 functions. RootSum and RootOf are not allowed.

If a CAS returns the above integral unevaluated within the time limit, then the result is counted as passed and assigned an A grade.

However, if CAS times out, then it is assigned an F grade even if the integral is not integrable, as this implies CAS could not determine that the integral is not integrable in the time limit.

If a CAS returns an antiderivative to such an integral, it is assigned an A grade automatically and this special result is listed in the introduction section of each individual test report to make it easy to identify as this can be important result to investigate.

The results given in in the table below reflects the above.

System	solved	Failed
Rubi	% 100. (70)	% 0. (0)
Mathematica	% 100. (70)	% 0. (0)
Maple	% 75.71 (53)	% 24.29 (17)
Maxima	% 40. (28)	% 60. (42)
Fricas	% 44.29 (31)	% 55.71 (39)
Sympy	% 10. (7)	% 90. (63)
Giac	% 40. (28)	% 60. (42)

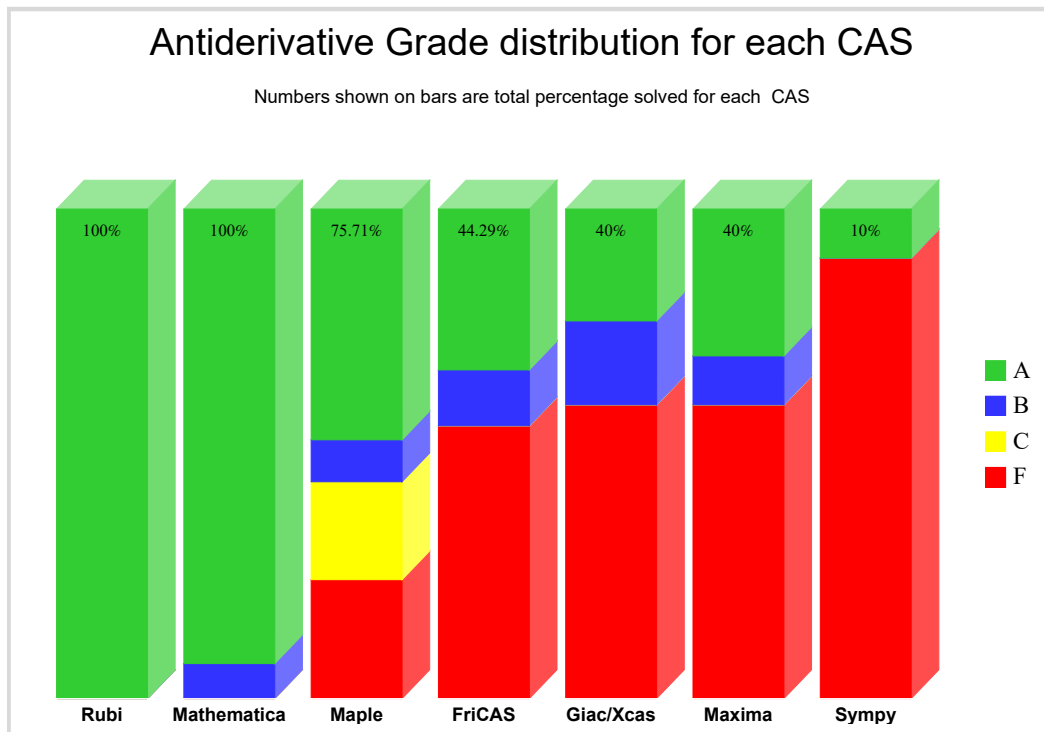
The table below gives additional break down of the grading of quality of the antiderivatives generated by each CAS. The grading is given using the letters A,B,C and F with A being the best quality. The grading is accomplished by comparing the antiderivative generated with the optimal antiderivatives included in the test suite. The following table describes the meaning of these grades.

grade	description
A	Integral was solved and antiderivative is optimal in quality and leaf size.
B	Integral was solved and antiderivative is optimal in quality but leaf size is larger than twice the optimal antiderivatives leaf size.
C	Integral was solved and antiderivative is non-optimal in quality. This can be due to one or more of the following reasons <ol style="list-style-type: none"> 1. antiderivative contains a hypergeometric function and the optimal antiderivative does not. 2. antiderivative contains a special function and the optimal antiderivative does not. 3. antiderivative contains the imaginary unit and the optimal antiderivative does not.
F	Integral was not solved. Either the integral was returned unevaluated within the time limit, or it timed out, or CAS hanged or crashed or an exception was raised.

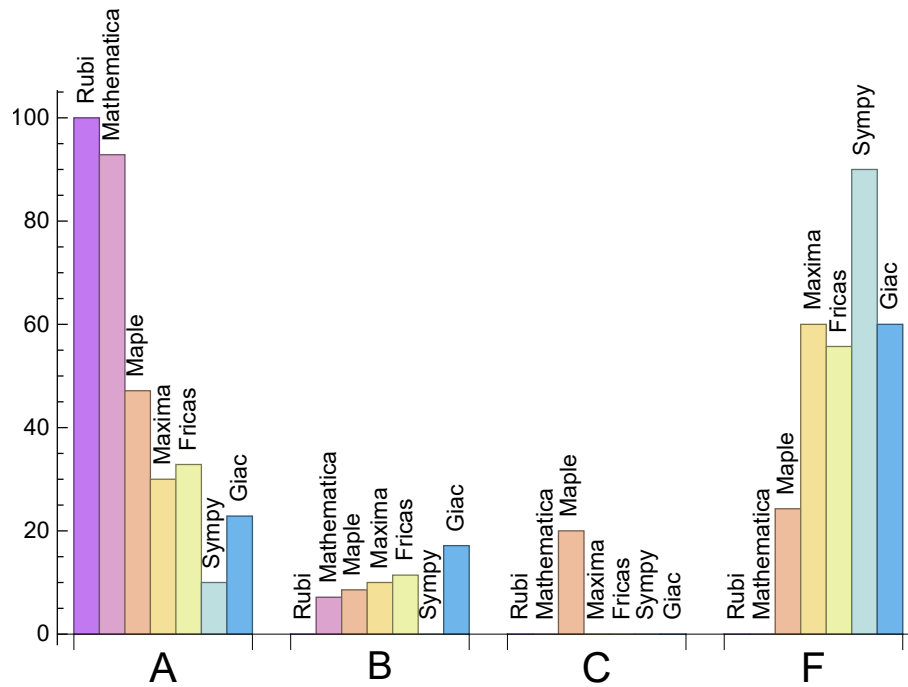
Grading is implemented for all CAS systems. Based on the above, the following table summarizes the grading for this test suite.

System	% A grade	% B grade	% C grade	% F grade
Rubi	100.	0.	0.	0.
Mathematica	92.86	7.14	0.	0.
Maple	47.14	8.57	20.	24.29
Maxima	30.	10.	0.	60.
Fricas	32.86	11.43	0.	55.71
Sympy	10.	0.	0.	90.
Giac	22.86	17.14	0.	60.

The following is a Bar chart illustration of the data in the above table.



The figure below compares the CAS systems for each grade level.



1.3 Performance

The table below summarizes the performance of each CAS system in terms of CPU time and leaf size of results.

System	Mean time (sec)	Mean size	Normalized mean	Median size	Normalized median
Rubi	0.03	60.49	1.	55.5	1.
Mathematica	0.08	52.73	1.06	52.5	0.89
Maple	0.3	158.85	2.51	69.	1.31
Maxima	1.95	349.82	7.	54.	1.25
Fricas	0.48	163.32	4.04	150.	3.4
Sympy	8.76	34.43	1.37	37.	1.08
Giac	1.31	85.57	2.02	72.5	1.75

1.4 list of integrals that has no closed form antiderivative

{

1.5 list of integrals solved by CAS but has no known antiderivative

Rubi {}

Mathematica {}

Maple {}

Maxima {}

Fricas {}

Sympy {}

Giac {}

1.6 list of integrals solved by CAS but failed verification

The following are integrals solved by CAS but the verification phase failed to verify the anti-derivative produced is correct. This does not mean necessarily that the anti-derivative is wrong, as additional methods of verification might be needed, or more time is needed (3 minutes time limit was used). These integrals are listed here to make it easier to do further investigation to determine why it was not possible to verify the result produced.

Rubi {}

Mathematica {}

Maple Verification phase not implemented yet.

Maxima Verification phase not implemented yet.

Fricas Verification phase not implemented yet.

Sympy Verification phase not implemented yet.

Giac Verification phase not implemented yet.

1.7 Timing

The command `AboluteTiming[]` was used in Mathematica to obtain the elapsed time for each integrate call. In Maple, the command `Usage` was used as in the following example

```
cpu_time := Usage(assign ('result_of _int',int(expr,x)),output='realtime')
```

For all other CAS systems, the elapsed time to complete each integral was found by taking the difference between the time after the call has completed from the time before the call was made. This was done using Python's `time.time()` call.

All elapsed times shown are in seconds. A time limit of 3 minutes was used for each integral. If the integrate command did not complete within this time limit, the integral was aborted and considered to have failed and assigned an F grade. The time used by failed integrals due to time out is not counted in the final statistics.

1.8 Verification

A verification phase was applied on the result of integration for Rubi and Mathematica. Future version of this report will implement verification for the other CAS systems. For the integrals whose result was not run through a verification phase, it is assumed that the antiderivative produced was correct.

Verification phase has 3 minutes time out. An integral whose result was not verified could still be correct. Further investigation is needed on those integrals which failed verifications. Such integrals are marked in the summary table below and also in each integral separate section so they are easy to identify and locate.

1.9 Important notes about some of the results

1.9.1 Important note about Maxima results

Since these integrals are run in a batch mode, using an automated script, and by using `sagemath` (SageMath uses Maxima), then any integral where Maxima needs an interactive response from the user to answer a question during evaluation of the integral in order to complete the integration, will fail and is counted as failed.

The exception raised is `ValueError`. Therefore Maxima result below is lower than what could result if Maxima was run directly and each question Maxima asks was answered correctly.

The percentage of such failures were not counted for each test file, but for an example, for the Timofeev test file, there were about 30 such integrals out of total 705, or about 4 percent. This percentage can be higher or lower depending on the specific input test file.

Such integrals can be identified by looking at the output of the integration in each section for Maxima. If the output was an exception `ValueError` then this is most likely due to this reason.

Maxima integrate was run using SageMath with the following settings set by default

```
'besselexpand : true'
'display2d : false'
'domain : complex'
'keepfloat : true'
'load(to_poly_solve)'
'load(simplify_sum)'
'load(abs_integrate)' 'load(diag)'
```

SageMath loading of Maxima `abs_integrate` was found to cause some problem. So the following code was added to disable this effect.

```
from sage.interfaces.maxima_lib import maxima_lib
maxima_lib.set('extra_definite_integration_methods', '[]')
maxima_lib.set('extra_integration_methods', '[]')
```

See <https://ask.sagemath.org/question/43088/integrate-results-that-are-different-from-using-maxima/> for reference.

1.9.2 Important note about FriCAS and Giac/X-CAS results

There are Few integrals which failed due to SageMath not able to translate the result back to SageMath syntax and not because these CAS system were not able to do the integrations.

These will fail With error `Exception raised: NotImplementedError`

The number of such cases seems to be very small. About 1 or 2 percent of all integrals.

Hopefully the next version of SageMath will have complete translation of FriCAS and XCAS syntax and I will re-run all the tests again when this happens.

1.9.3 Important note about finding leaf size of antiderivative

For Mathematica, Rubi and Maple, the builtin system function `LeafSize` is used to find the leaf size of each antiderivative.

The other CAS systems (SageMath and Sympy) do not have special builtin function for this purpose at this time. Therefore the leaf size is determined as follows.

For Fricas, Giac and Maxima (all called via `sagemath`) the following code is used

#see <https://stackoverflow.com/questions/25202346/how-to-obtain-leaf-count-expression-size-in>

```
def tree(expr):
    if expr.operator() is None:
        return expr
    else:
        return [expr.operator()+map(tree, expr.operands())

try:
    # 1.35 is a fudge factor since this estimate of leaf count is bit lower than
    #what it should be compared to Mathematica's
    leafCount = round(1.35*len(flatten(tree(anti))))
except Exception as ee:
    leafCount =1
```

For Sympy, called directly from Python, the following code is used

```
try:
    # 1.7 is a fudge factor since it is low side from actual leaf count
    leafCount = round(1.7*count_ops(anti))

except Exception as ee:
    leafCount =1
```

When these cas systems have a builtin function to find the leaf size of expressions, it will be used instead, and these tests run again.

1.10 Design of the test system

The following diagram gives a high level view of the current test build system.



One record (line) per one integral result. The line is CSV comma separated. It contains 13 fields. This is description of each record (line)

1. integer, the problem number.
2. integer. 0 or 1 for failed or passed. (this is not the grade field)
3. integer. Leaf size of result.
4. integer. Leaf size of the optimal antiderivative.
5. number. CPU time used to solve this integral. 0 if failed.
6. string. The integral in Latex format
7. string. The input used in CAS own syntax.
8. string. The result (antiderivative) produced by CAS in Latex format
9. string. The optimal antiderivative in Latex format.
10. integer. 0 or 1. Indicates if problem has known antiderivative or not
11. String. The result (antiderivative) in CAS own syntax.
12. String. The grade of the antiderivative. Can be "A", "B", "C", or "F"
13. String. The optimal antiderivative in CAS own syntax.

High level overview of the CAS independent integration test build system

Chapter 2

detailed summary tables of results

2.1 List of integrals sorted by grade for each CAS

2.1.1 Rubi

A grade: { 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70 }

B grade: { }

C grade: { }

F grade: { }

2.1.2 Mathematica

A grade: { 2, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70 }

B grade: { 1, 3, 5, 41, 42 }

C grade: { }

F grade: { }

2.1.3 Maple

A grade: { 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 44, 45, 46, 47, 48, 49, 50, 52, 53, 54, 61, 62, 63, 64, 65, 66, 67 }

B grade: { 39, 40, 41, 42, 43, 51 }

C grade: { 17, 18, 19, 20, 21, 22, 23, 24, 55, 56, 57, 58, 59, 60 }

F grade: { 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 68, 69, 70 }

2.1.4 Maxima

A grade: { 1, 2, 3, 4, 5, 6, 7, 8, 43, 44, 45, 46, 50, 51, 61, 62, 63, 64, 65, 66, 67 }

B grade: { 39, 40, 41, 42, 47, 48, 49 }

C grade: { }

F grade: { 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 52, 53, 54, 55, 56, 57, 58, 59, 60, 68, 69, 70 }

2.1.5 FriCAS

A grade: { 2, 4, 6, 8, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 61, 62, 63, 64, 65, 66, 67 }

B grade: { 1, 3, 5, 7, 39, 40, 41, 42 }

C grade: { }

F grade: { 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 55, 56, 57, 58, 59, 60, 68, 69, 70 }

2.1.6 Sympy

A grade: { 1, 43, 44, 45, 51, 52, 53 }

B grade: { }

C grade: { }

F grade: { 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 46, 47, 48, 49, 50, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70 }

2.1.7 Giac

A grade: { 1, 2, 4, 6, 8, 43, 45, 46, 50, 52, 53, 54, 61, 62, 63, 64 }

B grade: { 3, 5, 7, 39, 40, 41, 42, 44, 47, 48, 49, 51 }

C grade: { }

F grade: { 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 55, 56, 57, 58, 59, 60, 65, 66, 67, 68, 69, 70 }

2.2 Detailed conclusion table per each integral for all CAS systems

Detailed conclusion table per each integral is given by table below. The elapsed time is in seconds. For failed result it is given as F(-1) if the failure was due to timeout. It is given as F(-2) if the failure was due to an exception being raised, which could indicate a bug in the system. If the failure was due to integral not being evaluated within the time limit, then it is given just an F.

In this table, the column **normalized size** is defined as $\frac{\text{antiderivative leaf size}}{\text{optimal antiderivative leaf size}}$

Problem 1	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	B	A	A	B	A	A
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	12	12	38	20	26	93	37	20
normalized size	1	1.	3.17	1.67	2.17	7.75	3.08	1.67
time (sec)	N/A	0.004	0.018	0.012	1.055	0.474	2.515	1.301

Problem 2	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	A	A	F	A
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	11	11	11	12	18	43	0	18
normalized size	1	1.	1.	1.09	1.64	3.91	0.	1.64
time (sec)	N/A	0.008	0.008	0.011	1.017	0.448	0.	1.282

Problem 3	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	B	A	A	B	F	B
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	34	34	75	40	62	201	0	124
normalized size	1	1.	2.21	1.18	1.82	5.91	0.	3.65
time (sec)	N/A	0.014	0.013	0.022	1.042	0.485	0.	1.291

Problem 4	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	A	A	F	A
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	27	27	35	23	34	108	0	34
normalized size	1	1.	1.3	0.85	1.26	4.	0.	1.26
time (sec)	N/A	0.011	0.013	0.018	1.057	0.45	0.	1.254

Problem 5	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	B	A	A	B	F	B
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	55	55	113	59	96	313	0	186
normalized size	1	1.	2.05	1.07	1.75	5.69	0.	3.38
time (sec)	N/A	0.026	0.016	0.021	1.066	0.492	0.	1.288

Problem 6	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	A	A	F	A
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	42	42	56	33	47	166	0	47
normalized size	1	1.	1.33	0.79	1.12	3.95	0.	1.12
time (sec)	N/A	0.014	0.016	0.02	1.013	0.452	0.	1.261

Problem 7	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	A	B	F	B
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	76	76	151	78	123	424	0	246
normalized size	1	1.	1.99	1.03	1.62	5.58	0.	3.24
time (sec)	N/A	0.036	0.014	0.022	1.041	0.498	0.	1.294

Problem 8	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	A	A	F	A
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	55	55	77	43	61	223	0	61
normalized size	1	1.	1.4	0.78	1.11	4.05	0.	1.11
time (sec)	N/A	0.017	0.011	0.02	1.011	0.461	0.	1.229

Problem 9	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	F	F	F(-1)	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	90	90	63	160	0	0	0	0
normalized size	1	1.	0.7	1.78	0.	0.	0.	0.
time (sec)	N/A	0.037	0.201	1.171	0.	0.	0.	0.

Problem 10	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	F	F	F(-1)	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	67	67	50	88	0	0	0	0
normalized size	1	1.	0.75	1.31	0.	0.	0.	0.
time (sec)	N/A	0.026	0.081	1.2	0.	0.	0.	0.

Problem 11	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	63	63	49	132	0	0	0	0
normalized size	1	1.	0.78	2.1	0.	0.	0.	0.
time (sec)	N/A	0.024	0.058	1.344	0.	0.	0.	0.

Problem 12	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	41	41	40	69	0	0	0	0
normalized size	1	1.	0.98	1.68	0.	0.	0.	0.
time (sec)	N/A	0.017	0.034	0.836	0.	0.	0.	0.

Problem 13	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	41	41	40	91	0	0	0	0
normalized size	1	1.	0.98	2.22	0.	0.	0.	0.
time (sec)	N/A	0.017	0.039	1.095	0.	0.	0.	0.

Problem 14	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	67	67	53	88	0	0	0	0
normalized size	1	1.	0.79	1.31	0.	0.	0.	0.
time (sec)	N/A	0.027	0.057	1.323	0.	0.	0.	0.

Problem 15	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	67	67	60	142	0	0	0	0
normalized size	1	1.	0.9	2.12	0.	0.	0.	0.
time (sec)	N/A	0.026	0.107	1.229	0.	0.	0.	0.

Problem 16	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	F	F	F(-1)	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	90	90	65	104	0	0	0	0
normalized size	1	1.	0.72	1.16	0.	0.	0.	0.
time (sec)	N/A	0.038	0.166	1.198	0.	0.	0.	0.

Problem 17	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	C	F	F	F(-1)	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	103	103	67	1029	0	0	0	0
normalized size	1	1.	0.65	9.99	0.	0.	0.	0.
time (sec)	N/A	0.053	0.196	0.335	0.	0.	0.	0.

Problem 18	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	C	F	F	F(-1)	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	75	75	55	319	0	0	0	0
normalized size	1	1.	0.73	4.25	0.	0.	0.	0.
time (sec)	N/A	0.031	0.187	0.241	0.	0.	0.	0.

Problem 19	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	C	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	71	71	54	520	0	0	0	0
normalized size	1	1.	0.76	7.32	0.	0.	0.	0.
time (sec)	N/A	0.032	0.127	0.219	0.	0.	0.	0.

Problem 20	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	C	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	43	43	42	165	0	0	0	0
normalized size	1	1.	0.98	3.84	0.	0.	0.	0.
time (sec)	N/A	0.018	0.036	0.196	0.	0.	0.	0.

Problem 21	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	C	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	43	43	42	521	0	0	0	0
normalized size	1	1.	0.98	12.12	0.	0.	0.	0.
time (sec)	N/A	0.018	0.032	0.255	0.	0.	0.	0.

Problem 22	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	C	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	77	77	63	189	0	0	0	0
normalized size	1	1.	0.82	2.45	0.	0.	0.	0.
time (sec)	N/A	0.033	0.082	0.215	0.	0.	0.	0.

Problem 23	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	C	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	77	77	60	547	0	0	0	0
normalized size	1	1.	0.78	7.1	0.	0.	0.	0.
time (sec)	N/A	0.032	0.143	0.252	0.	0.	0.	0.

Problem 24	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	C	F	F	F(-1)	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	105	105	70	216	0	0	0	0
normalized size	1	1.	0.67	2.06	0.	0.	0.	0.
time (sec)	N/A	0.049	0.144	0.275	0.	0.	0.	0.

Problem 25	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	F	F	F	F(-1)	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	51	51	54	0	0	0	0	0
normalized size	1	1.	1.06	0.	0.	0.	0.	0.
time (sec)	N/A	0.022	0.078	0.104	0.	0.	0.	0.

Problem 26	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	F	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	51	51	51	0	0	0	0	0
normalized size	1	1.	1.	0.	0.	0.	0.	0.
time (sec)	N/A	0.022	0.059	0.145	0.	0.	0.	0.

Problem 27	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	F	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	53	53	51	0	0	0	0	0
normalized size	1	1.	0.96	0.	0.	0.	0.	0.
time (sec)	N/A	0.022	0.054	0.166	0.	0.	0.	0.

Problem 28	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	F	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	53	53	51	0	0	0	0	0
normalized size	1	1.	0.96	0.	0.	0.	0.	0.
time (sec)	N/A	0.021	0.048	0.143	0.	0.	0.	0.

Problem 29	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	F	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	53	53	51	0	0	0	0	0
normalized size	1	1.	0.96	0.	0.	0.	0.	0.
time (sec)	N/A	0.021	0.093	0.142	0.	0.	0.	0.

Problem 30	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	F	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	53	53	68	0	0	0	0	0
normalized size	1	1.	1.28	0.	0.	0.	0.	0.
time (sec)	N/A	0.021	0.142	0.09	0.	0.	0.	0.

Problem 31	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	F	F	F	F(-1)	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	54	54	57	0	0	0	0	0
normalized size	1	1.	1.06	0.	0.	0.	0.	0.
time (sec)	N/A	0.03	0.047	0.112	0.	0.	0.	0.

Problem 32	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	F	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	54	54	59	0	0	0	0	0
normalized size	1	1.	1.09	0.	0.	0.	0.	0.
time (sec)	N/A	0.027	0.068	0.146	0.	0.	0.	0.

Problem 33	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	F	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	56	56	59	0	0	0	0	0
normalized size	1	1.	1.05	0.	0.	0.	0.	0.
time (sec)	N/A	0.026	0.07	0.263	0.	0.	0.	0.

Problem 34	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	F	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	56	56	59	0	0	0	0	0
normalized size	1	1.	1.05	0.	0.	0.	0.	0.
time (sec)	N/A	0.026	0.066	0.142	0.	0.	0.	0.

Problem 35	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	F	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	56	56	59	0	0	0	0	0
normalized size	1	1.	1.05	0.	0.	0.	0.	0.
time (sec)	N/A	0.027	0.064	0.288	0.	0.	0.	0.

Problem 36	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	F	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	56	56	76	0	0	0	0	0
normalized size	1	1.	1.36	0.	0.	0.	0.	0.
time (sec)	N/A	0.027	0.156	0.093	0.	0.	0.	0.

Problem 37	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	F	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	69	69	59	0	0	0	0	0
normalized size	1	1.	0.86	0.	0.	0.	0.	0.
time (sec)	N/A	0.026	0.092	0.641	0.	0.	0.	0.

Problem 38	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	F	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	72	72	65	0	0	0	0	0
normalized size	1	1.	0.9	0.	0.	0.	0.	0.
time (sec)	N/A	0.03	0.076	0.619	0.	0.	0.	0.

Problem 39	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	B	B	B	F(-1)	B
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	50	50	92	101	2253	302	0	174
normalized size	1	1.	1.84	2.02	45.06	6.04	0.	3.48
time (sec)	N/A	0.017	0.258	0.119	1.969	0.487	0.	1.291

Problem 40	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	B	B	B	F(-1)	B
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	36	36	72	78	1173	227	0	135
normalized size	1	1.	2.	2.17	32.58	6.31	0.	3.75
time (sec)	N/A	0.012	0.243	0.17	1.767	0.481	0.	1.239

Problem 41	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	B	B	B	B	F	B
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	22	22	51	52	405	150	0	93
normalized size	1	1.	2.32	2.36	18.41	6.82	0.	4.23
time (sec)	N/A	0.009	0.087	0.086	1.674	0.473	0.	1.308

Problem 42	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	B	B	B	B	F	B
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	5	5	28	31	47	77	0	16
normalized size	1	1.	5.6	6.2	9.4	15.4	0.	3.2
time (sec)	N/A	0.007	0.013	0.181	1.646	0.471	0.	1.245

Problem 43	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	B	A	A	A	A
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	12	12	12	26	14	12	12	15
normalized size	1	1.	1.	2.17	1.17	1.	1.	1.25
time (sec)	N/A	0.009	0.007	0.127	1.502	0.463	0.476	1.329

Problem 44	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	A	A	A	B
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	29	29	23	30	15	31	29	59
normalized size	1	1.	0.79	1.03	0.52	1.07	1.	2.03
time (sec)	N/A	0.011	0.017	0.082	1.635	0.462	1.478	1.311

Problem 45	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	A	A	A	A
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	43	43	31	38	23	53	46	82
normalized size	1	1.	0.72	0.88	0.53	1.23	1.07	1.91
time (sec)	N/A	0.015	0.027	0.077	1.665	0.471	19.723	1.302

Problem 46	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	A	A	F(-1)	A
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	57	57	37	44	31	66	0	105
normalized size	1	1.	0.65	0.77	0.54	1.16	0.	1.84
time (sec)	N/A	0.019	0.041	0.08	1.639	0.472	0.	1.239

Problem 47	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	B	A	F(-1)	B
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	84	84	61	102	2947	286	0	221
normalized size	1	1.	0.73	1.21	35.08	3.4	0.	2.63
time (sec)	N/A	0.04	0.324	0.116	14.647	0.508	0.	1.431

Problem 48	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	B	A	F(-1)	B
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	65	65	51	79	1503	219	0	167
normalized size	1	1.	0.78	1.22	23.12	3.37	0.	2.57
time (sec)	N/A	0.029	0.217	0.088	2.664	0.496	0.	1.286

Problem 49	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	B	A	F	B
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	46	46	39	53	429	136	0	97
normalized size	1	1.	0.85	1.15	9.33	2.96	0.	2.11
time (sec)	N/A	0.022	0.072	0.078	1.691	0.487	0.	1.322

Problem 50	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	A	A	F	A
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	26	26	30	32	32	188	0	18
normalized size	1	1.	1.15	1.23	1.23	7.23	0.	0.69
time (sec)	N/A	0.016	0.016	0.126	1.667	0.494	0.	1.239

Problem 51	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	B	A	A	A	B
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	14	14	14	27	18	57	17	46
normalized size	1	1.	1.	1.93	1.29	4.07	1.21	3.29
time (sec)	N/A	0.013	0.006	0.132	1.497	0.469	0.789	1.282

Problem 52	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	F	A	A	A
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	36	36	27	31	0	84	39	58
normalized size	1	1.	0.75	0.86	0.	2.33	1.08	1.61
time (sec)	N/A	0.018	0.021	0.076	0.	0.471	3.578	1.385

Problem 53	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	F	A	A	A
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	55	55	36	39	0	109	61	76
normalized size	1	1.	0.65	0.71	0.	1.98	1.11	1.38
time (sec)	N/A	0.027	0.034	0.081	0.	0.481	32.76	1.449

Problem 54	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	F	A	F(-1)	A
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	74	74	42	45	0	127	0	93
normalized size	1	1.	0.57	0.61	0.	1.72	0.	1.26
time (sec)	N/A	0.036	0.045	0.076	0.	0.489	0.	1.48

Problem 55	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	C	F	F	F(-1)	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	123	123	58	1313	0	0	0	0
normalized size	1	1.	0.47	10.67	0.	0.	0.	0.
time (sec)	N/A	0.06	0.189	0.222	0.	0.	0.	0.

Problem 56	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	C	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	71	71	46	372	0	0	0	0
normalized size	1	1.	0.65	5.24	0.	0.	0.	0.
time (sec)	N/A	0.038	0.113	0.319	0.	0.	0.	0.

Problem 57	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	C	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	48	48	46	343	0	0	0	0
normalized size	1	1.	0.96	7.15	0.	0.	0.	0.
time (sec)	N/A	0.027	0.041	0.278	0.	0.	0.	0.

Problem 58	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	C	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	50	50	38	125	0	0	0	0
normalized size	1	1.	0.76	2.5	0.	0.	0.	0.
time (sec)	N/A	0.03	0.049	0.25	0.	0.	0.	0.

Problem 59	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	C	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	79	79	52	349	0	0	0	0
normalized size	1	1.	0.66	4.42	0.	0.	0.	0.
time (sec)	N/A	0.038	0.095	0.235	0.	0.	0.	0.

Problem 60	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	C	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	123	123	63	158	0	0	0	0
normalized size	1	1.	0.51	1.28	0.	0.	0.	0.
time (sec)	N/A	0.061	0.147	0.264	0.	0.	0.	0.

Problem 61	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	A	A	F(-1)	A
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	164	164	59	53	89	360	0	93
normalized size	1	1.	0.36	0.32	0.54	2.2	0.	0.57
time (sec)	N/A	0.035	0.058	0.273	1.5	0.547	0.	1.298

Problem 62	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	A	A	F(-1)	A
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	118	118	47	41	65	252	0	69
normalized size	1	1.	0.4	0.35	0.55	2.14	0.	0.58
time (sec)	N/A	0.028	0.036	0.175	1.499	0.493	0.	1.276

Problem 63	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	A	A	F	A
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	62	62	33	29	41	150	0	31
normalized size	1	1.	0.53	0.47	0.66	2.42	0.	0.5
time (sec)	N/A	0.021	0.02	0.096	1.511	0.471	0.	1.296

Problem 64	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	A	A	F	A
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	16	16	16	18	12	70	0	12
normalized size	1	1.	1.	1.12	0.75	4.38	0.	0.75
time (sec)	N/A	0.015	0.006	0.138	1.528	0.466	0.	1.351

Problem 65	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	A	A	F	F(-2)
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	36	36	25	24	34	122	0	0
normalized size	1	1.	0.69	0.67	0.94	3.39	0.	0.
time (sec)	N/A	0.016	0.025	0.163	1.497	0.489	0.	0.

Problem 66	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	A	A	F	F(-2)
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	86	86	38	41	78	178	0	0
normalized size	1	1.	0.44	0.48	0.91	2.07	0.	0.
time (sec)	N/A	0.029	0.043	0.205	1.524	0.495	0.	0.

Problem 67	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	A	A	A	F	F(-2)
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	132	132	55	57	119	236	0	0
normalized size	1	1.	0.42	0.43	0.9	1.79	0.	0.
time (sec)	N/A	0.045	0.095	0.245	1.535	0.524	0.	0.

Problem 68	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	F	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	80	80	71	0	0	0	0	0
normalized size	1	1.	0.89	0.	0.	0.	0.	0.
time (sec)	N/A	0.05	0.115	0.765	0.	0.	0.	0.

Problem 69	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	F	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	82	82	73	0	0	0	0	0
normalized size	1	1.	0.89	0.	0.	0.	0.	0.
time (sec)	N/A	0.049	0.088	0.343	0.	0.	0.	0.

Problem 70	Optimal	Rubi	Mathematica	Maple	Maxima	Fricas	Sympy	Giac
grade	A	A	A	F	F	F	F	F
verified	N/A	Yes	Yes	TBD	TBD	TBD	TBD	TBD
size	91	91	77	0	0	0	0	0
normalized size	1	1.	0.85	0.	0.	0.	0.	0.
time (sec)	N/A	0.045	0.141	1.082	0.	0.	0.	0.

2.3 Detailed conclusion table specific for Rubi results

The following table is specific to Rubi. It gives additional statistics for each integral. the column **steps** is the number of steps used by Rubi to obtain the antiderivative. The **rules** column is the number of unique rules used. The **integrand size** column is the leaf size of the integrand. Finally the ratio $\frac{\text{number of rules}}{\text{integrand size}}$ is given. The larger this ratio is, the harder the integral was to solve. In this test, problem number [47] had the largest ratio of [0.4]

Table 2.1: Rubi specific breakdown of results for each integral

#	grade	number of steps used	number of unique rules	normalized antiderivative leaf size	integrand leaf size	$\frac{\text{number of rules}}{\text{integrand leaf size}}$
1	A	1	1	1.	6	0.167
2	A	2	2	1.	8	0.25
3	A	2	2	1.	8	0.25
4	A	2	1	1.	8	0.125
5	A	3	2	1.	8	0.25
6	A	2	1	1.	8	0.125
7	A	4	2	1.	8	0.25
8	A	2	1	1.	8	0.125

Continued on next page

Table 2.1 – continued from previous page

#	grade	number of steps used	number of unique rules	normalized antiderivative leaf size	integrand leaf size	$\frac{\text{number of rules}}{\text{integrand leaf size}}$
9	A	4	3	1.	10	0.3
10	A	3	3	1.	10	0.3
11	A	3	3	1.	10	0.3
12	A	2	2	1.	10	0.2
13	A	2	2	1.	10	0.2
14	A	3	3	1.	10	0.3
15	A	3	3	1.	10	0.3
16	A	4	3	1.	10	0.3
17	A	4	3	1.	12	0.25
18	A	3	3	1.	12	0.25
19	A	3	3	1.	12	0.25
20	A	2	2	1.	12	0.167
21	A	2	2	1.	12	0.167
22	A	3	3	1.	12	0.25
23	A	3	3	1.	12	0.25
24	A	4	3	1.	12	0.25
25	A	2	2	1.	10	0.2
26	A	2	2	1.	10	0.2
27	A	2	2	1.	10	0.2
28	A	2	2	1.	10	0.2
29	A	2	2	1.	10	0.2
30	A	2	2	1.	10	0.2
31	A	2	2	1.	12	0.167
32	A	2	2	1.	12	0.167
33	A	2	2	1.	12	0.167
34	A	2	2	1.	12	0.167
35	A	2	2	1.	12	0.167
36	A	2	2	1.	12	0.167
37	A	2	2	1.	8	0.25
38	A	2	2	1.	10	0.2
39	A	5	3	1.	8	0.375
40	A	4	3	1.	8	0.375

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Table 2.1 – continued from previous page

#	grade	number of steps used	number of unique rules	normalized antiderivative leaf size	integrand leaf size	$\frac{\text{number of rules}}{\text{integrand leaf size}}$
41	A	3	3	1.	8	0.375
42	A	2	2	1.	8	0.25
43	A	2	2	1.	8	0.25
44	A	3	3	1.	8	0.375
45	A	4	3	1.	8	0.375
46	A	5	3	1.	8	0.375
47	A	6	4	1.	10	0.4
48	A	5	4	1.	10	0.4
49	A	4	4	1.	10	0.4
50	A	3	3	1.	10	0.3
51	A	2	2	1.	10	0.2
52	A	3	3	1.	10	0.3
53	A	4	3	1.	10	0.3
54	A	5	3	1.	10	0.3
55	A	7	4	1.	10	0.4
56	A	5	4	1.	10	0.4
57	A	4	4	1.	10	0.4
58	A	4	4	1.	10	0.4
59	A	5	4	1.	10	0.4
60	A	7	4	1.	10	0.4
61	A	3	2	1.	10	0.2
62	A	3	2	1.	10	0.2
63	A	3	2	1.	10	0.2
64	A	3	3	1.	10	0.3
65	A	3	3	1.	10	0.3
66	A	5	3	1.	10	0.3
67	A	7	3	1.	10	0.3
68	A	3	3	1.	12	0.25
69	A	3	3	1.	14	0.214
70	A	3	3	1.	21	0.143

Chapter 3

Listing of integrals

3.1 $\int \csc(a + bx) dx$

Optimal. Leaf size=12

$$\frac{\tanh^{-1}(\cos(a + bx))}{b}$$

[Out] $-(\text{ArcTanh}[\text{Cos}[a + b*x]])/b$

Rubi [A] time = 0.0042156, antiderivative size = 12, normalized size of antiderivative = 1., number of steps used = 1, number of rules used = 1, integrand size = 6, $\frac{\text{number of rules}}{\text{integrand size}} = 0.167$, Rules used = {3770}

$$\frac{\tanh^{-1}(\cos(a + bx))}{b}$$

Antiderivative was successfully verified.

[In] $\text{Int}[\text{Csc}[a + b*x], x]$

[Out] $-(\text{ArcTanh}[\text{Cos}[a + b*x]])/b$

Rule 3770

$\text{Int}[\csc[(c_.) + (d_.)*(x_.)], x_Symbol] \rightarrow -\text{Simp}[\text{ArcTanh}[\text{Cos}[c + d*x]]/d, x]$
/; FreeQ[{c, d}, x]

Rubi steps

$$\int \csc(a + bx) dx = -\frac{\tanh^{-1}(\cos(a + bx))}{b}$$

Mathematica [B] time = 0.0181638, size = 38, normalized size = 3.17

$$\frac{\log\left(\sin\left(\frac{a}{2} + \frac{bx}{2}\right)\right)}{b} - \frac{\log\left(\cos\left(\frac{a}{2} + \frac{bx}{2}\right)\right)}{b}$$

Antiderivative was successfully verified.

[In] Integrate[Csc[a + b*x], x]

[Out] -(Log[Cos[a/2 + (b*x)/2]]/b) + Log[Sin[a/2 + (b*x)/2]]/b

Maple [A] time = 0.012, size = 20, normalized size = 1.7

$$-\frac{\ln(\csc(bx + a) + \cot(bx + a))}{b}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(csc(b*x+a), x)

[Out] -1/b*ln(csc(b*x+a)+cot(b*x+a))

Maxima [A] time = 1.05517, size = 26, normalized size = 2.17

$$-\frac{\log(\cot(bx + a) + \csc(bx + a))}{b}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a), x, algorithm="maxima")

[Out] $-\log(\cot(b*x + a) + \csc(b*x + a))/b$

Fricas [B] time = 0.473559, size = 93, normalized size = 7.75

$$\frac{\log\left(\frac{1}{2}\cos(bx+a)+\frac{1}{2}\right)-\log\left(-\frac{1}{2}\cos(bx+a)+\frac{1}{2}\right)}{2b}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(csc(b*x+a),x, algorithm="fricas")`

[Out] $-1/2*(\log(1/2*\cos(b*x + a) + 1/2) - \log(-1/2*\cos(b*x + a) + 1/2))/b$

Sympy [A] time = 2.51486, size = 37, normalized size = 3.08

$$\begin{cases} -\frac{\log(\cot(a+bx)+\csc(a+bx))}{b} & \text{for } b \neq 0 \\ \frac{x(\cot(a)\csc(a)+\csc^2(a))}{\cot(a)+\csc(a)} & \text{otherwise} \end{cases}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(csc(b*x+a),x)`

[Out] `Piecewise((-log(cot(a + b*x) + csc(a + b*x))/b, Ne(b, 0)), (x*(cot(a)*csc(a) + csc(a)**2)/(cot(a) + csc(a)), True))`

Giac [A] time = 1.30093, size = 20, normalized size = 1.67

$$\frac{\log\left(\left|\tan\left(\frac{1}{2}bx + \frac{1}{2}a\right)\right|\right)}{b}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(csc(b*x+a),x, algorithm="giac")`

[Out] $\log(\text{abs}(\tan(1/2*b*x + 1/2*a)))/b$

3.2 $\int \csc^2(a + bx) dx$

Optimal. Leaf size=11

$$-\frac{\cot(a + bx)}{b}$$

[Out] -(Cot[a + b*x]/b)

Rubi [A] time = 0.0083176, antiderivative size = 11, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 8, $\frac{\text{number of rules}}{\text{integrand size}} = 0.25$, Rules used = {3767, 8}

$$-\frac{\cot(a + bx)}{b}$$

Antiderivative was successfully verified.

[In] Int[Csc[a + b*x]^2,x]

[Out] -(Cot[a + b*x]/b)

Rule 3767

```
Int[csc[(c_.) + (d_.)*(x_)]^(n_), x_Symbol] :> -Dist[d^(-1), Subst[Int[ExpandIntegrand[(1 + x^2)^(n/2 - 1), x], x], x, Cot[c + d*x]], x] /; FreeQ[{c, d}, x] && IGtQ[n/2, 0]
```

Rule 8

```
Int[a_, x_Symbol] :> Simp[a*x, x] /; FreeQ[a, x]
```

Rubi steps

$$\begin{aligned} \int \csc^2(a + bx) dx &= -\frac{\text{Subst}(\int 1 dx, x, \cot(a + bx))}{b} \\ &= -\frac{\cot(a + bx)}{b} \end{aligned}$$

Mathematica [A] time = 0.0082027, size = 11, normalized size = 1.

$$-\frac{\cot(a + bx)}{b}$$

Antiderivative was successfully verified.

[In] Integrate[Csc[a + b*x]^2, x]

[Out] -(Cot[a + b*x])/b

Maple [A] time = 0.011, size = 12, normalized size = 1.1

$$-\frac{\cot(bx + a)}{b}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(csc(b*x+a)^2, x)

[Out] -cot(b*x+a)/b

Maxima [A] time = 1.01663, size = 18, normalized size = 1.64

$$-\frac{1}{b \tan(bx + a)}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^2, x, algorithm="maxima")

[Out] -1/(b*tan(b*x + a))

Fricas [A] time = 0.448256, size = 43, normalized size = 3.91

$$-\frac{\cos(bx + a)}{b \sin(bx + a)}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^2,x, algorithm="fricas")

[Out] -cos(b*x + a)/(b*sin(b*x + a))

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \csc^2(a + bx) dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)**2,x)

[Out] Integral(csc(a + b*x)**2, x)

Giac [A] time = 1.28183, size = 18, normalized size = 1.64

$$-\frac{1}{b \tan(bx + a)}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^2,x, algorithm="giac")

[Out] -1/(b*tan(b*x + a))

3.3 $\int \csc^3(a + bx) dx$

Optimal. Leaf size=34

$$-\frac{\tanh^{-1}(\cos(a + bx))}{2b} - \frac{\cot(a + bx) \csc(a + bx)}{2b}$$

[Out] $-\text{ArcTanh}[\text{Cos}[a + b*x]]/(2*b) - (\text{Cot}[a + b*x]*\text{Csc}[a + b*x])/(2*b)$

Rubi [A] time = 0.0138963, antiderivative size = 34, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 8, $\frac{\text{number of rules}}{\text{integrand size}} = 0.25$, Rules used = {3768, 3770}

$$-\frac{\tanh^{-1}(\cos(a + bx))}{2b} - \frac{\cot(a + bx) \csc(a + bx)}{2b}$$

Antiderivative was successfully verified.

[In] $\text{Int}[\text{Csc}[a + b*x]^3, x]$

[Out] $-\text{ArcTanh}[\text{Cos}[a + b*x]]/(2*b) - (\text{Cot}[a + b*x]*\text{Csc}[a + b*x])/(2*b)$

Rule 3768

$\text{Int}[(\text{csc}[(c_.) + (d_.)*(x_.)]*(b_.))^{(n_.)}, x_Symbol] \text{ :> } -\text{Simp}[(b*\text{Cos}[c + d*x] * (b*\text{Csc}[c + d*x])^{(n - 1)})/(d*(n - 1)), x] + \text{Dist}[(b^2*(n - 2))/(n - 1), \text{Int}[(b*\text{Csc}[c + d*x])^{(n - 2)}, x], x] \text{ /; } \text{FreeQ}\{b, c, d\}, x] \ \&\& \ \text{GtQ}[n, 1] \ \&\& \ \text{IntegerQ}[2*n]$

Rule 3770

$\text{Int}[\text{csc}[(c_.) + (d_.)*(x_.)], x_Symbol] \text{ :> } -\text{Simp}[\text{ArcTanh}[\text{Cos}[c + d*x]]/d, x] \text{ /; } \text{FreeQ}\{c, d\}, x]$

Rubi steps

$$\begin{aligned} \int \csc^3(a + bx) dx &= -\frac{\cot(a + bx) \csc(a + bx)}{2b} + \frac{1}{2} \int \csc(a + bx) dx \\ &= -\frac{\tanh^{-1}(\cos(a + bx))}{2b} - \frac{\cot(a + bx) \csc(a + bx)}{2b} \end{aligned}$$

Mathematica [B] time = 0.0129009, size = 75, normalized size = 2.21

$$-\frac{\csc^2\left(\frac{1}{2}(a+bx)\right)}{8b} + \frac{\sec^2\left(\frac{1}{2}(a+bx)\right)}{8b} + \frac{\log\left(\sin\left(\frac{1}{2}(a+bx)\right)\right)}{2b} - \frac{\log\left(\cos\left(\frac{1}{2}(a+bx)\right)\right)}{2b}$$

Antiderivative was successfully verified.

[In] Integrate[Csc[a + b*x]^3, x]

[Out] -Csc[(a + b*x)/2]^2/(8*b) - Log[Cos[(a + b*x)/2]]/(2*b) + Log[Sin[(a + b*x)/2]]/(2*b) + Sec[(a + b*x)/2]^2/(8*b)

Maple [A] time = 0.022, size = 40, normalized size = 1.2

$$-\frac{\csc(bx+a)\cot(bx+a)}{2b} + \frac{\ln(\csc(bx+a) - \cot(bx+a))}{2b}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(csc(b*x+a)^3, x)

[Out] -1/2*cot(b*x+a)*csc(b*x+a)/b+1/2/b*ln(csc(b*x+a)-cot(b*x+a))

Maxima [A] time = 1.04182, size = 62, normalized size = 1.82

$$\frac{\frac{2 \cos(bx+a)}{\cos(bx+a)^2-1} - \log(\cos(bx+a) + 1) + \log(\cos(bx+a) - 1)}{4b}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^3, x, algorithm="maxima")

[Out] 1/4*(2*cos(b*x + a)/(cos(b*x + a)^2 - 1) - log(cos(b*x + a) + 1) + log(cos(b*x + a) - 1))/b

Fricas [B] time = 0.484921, size = 201, normalized size = 5.91

$$\frac{(\cos(bx+a)^2-1)\log\left(\frac{1}{2}\cos(bx+a)+\frac{1}{2}\right)-(\cos(bx+a)^2-1)\log\left(-\frac{1}{2}\cos(bx+a)+\frac{1}{2}\right)-2\cos(bx+a)}{4(b\cos(bx+a)^2-b)}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^3,x, algorithm="fricas")

[Out] -1/4*((cos(b*x + a)^2 - 1)*log(1/2*cos(b*x + a) + 1/2) - (cos(b*x + a)^2 - 1)*log(-1/2*cos(b*x + a) + 1/2) - 2*cos(b*x + a))/(b*cos(b*x + a)^2 - b)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \csc^3(a + bx) dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)**3,x)

[Out] Integral(csc(a + b*x)**3, x)

Giac [B] time = 1.29105, size = 124, normalized size = 3.65

$$-\frac{\left(\frac{2(\cos(bx+a)-1)}{\cos(bx+a)+1}-1\right)(\cos(bx+a)+1)}{\cos(bx+a)-1} + \frac{\cos(bx+a)-1}{\cos(bx+a)+1} - 2 \log\left(\frac{|\cos(bx+a)+1|}{|\cos(bx+a)-1|}\right)}{8b}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^3,x, algorithm="giac")

[Out] -1/8*((2*(cos(b*x + a) - 1)/(cos(b*x + a) + 1) - 1)*(cos(b*x + a) + 1)/(cos(b*x + a) - 1) + (cos(b*x + a) - 1)/(cos(b*x + a) + 1) - 2*log(abs(-cos(b*x + a) + 1)/abs(cos(b*x + a) + 1)))/b

3.4 $\int \csc^4(a + bx) dx$

Optimal. Leaf size=27

$$-\frac{\cot^3(a + bx)}{3b} - \frac{\cot(a + bx)}{b}$$

[Out] $-(\text{Cot}[a + b*x]/b) - \text{Cot}[a + b*x]^3/(3*b)$

Rubi [A] time = 0.0113776, antiderivative size = 27, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 1, integrand size = 8, $\frac{\text{number of rules}}{\text{integrand size}} = 0.125$, Rules used = {3767}

$$-\frac{\cot^3(a + bx)}{3b} - \frac{\cot(a + bx)}{b}$$

Antiderivative was successfully verified.

[In] $\text{Int}[\text{Csc}[a + b*x]^4, x]$

[Out] $-(\text{Cot}[a + b*x]/b) - \text{Cot}[a + b*x]^3/(3*b)$

Rule 3767

$\text{Int}[\text{csc}[(c_.) + (d_.)*(x_.)]^{(n_.)}, x_Symbol] \rightarrow -\text{Dist}[d^{(-1)}, \text{Subst}[\text{Int}[\text{ExpandIntegrand}[(1 + x^2)^{(n/2 - 1)}, x], x], x, \text{Cot}[c + d*x]], x] /; \text{FreeQ}\{c, d\}, x] \ \&\& \ \text{IGtQ}[n/2, 0]$

Rubi steps

$$\begin{aligned} \int \csc^4(a + bx) dx &= -\frac{\text{Subst}\left(\int (1 + x^2) dx, x, \cot(a + bx)\right)}{b} \\ &= -\frac{\cot(a + bx)}{b} - \frac{\cot^3(a + bx)}{3b} \end{aligned}$$

Mathematica [A] time = 0.012798, size = 35, normalized size = 1.3

$$-\frac{2 \cot(a + bx)}{3b} - \frac{\cot(a + bx) \csc^2(a + bx)}{3b}$$

Antiderivative was successfully verified.

[In] Integrate[Csc[a + b*x]^4,x]

[Out] $(-2*\text{Cot}[a + b*x])/(3*b) - (\text{Cot}[a + b*x]*\text{Csc}[a + b*x]^2)/(3*b)$

Maple [A] time = 0.018, size = 23, normalized size = 0.9

$$\frac{\cot (bx + a)}{b} \left(-\frac{2}{3} - \frac{(\csc (bx + a))^2}{3} \right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(csc(b*x+a)^4,x)

[Out] $1/b*(-2/3-1/3*\csc(b*x+a)^2)*\cot(b*x+a)$

Maxima [A] time = 1.05666, size = 34, normalized size = 1.26

$$-\frac{3 \tan (bx + a)^2 + 1}{3 b \tan (bx + a)^3}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^4,x, algorithm="maxima")

[Out] $-1/3*(3*\tan(b*x + a)^2 + 1)/(b*\tan(b*x + a)^3)$

Fricas [A] time = 0.450437, size = 108, normalized size = 4.

$$\frac{2 \cos (bx + a)^3 - 3 \cos (bx + a)}{3 (b \cos (bx + a)^2 - b) \sin (bx + a)}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^4,x, algorithm="fricas")

[Out] $-1/3*(2*\cos(b*x + a)^3 - 3*\cos(b*x + a))/((b*\cos(b*x + a)^2 - b)*\sin(b*x + a))$

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \csc^4(a + bx) dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(csc(b*x+a)**4,x)`

[Out] `Integral(csc(a + b*x)**4, x)`

Giac [A] time = 1.2539, size = 34, normalized size = 1.26

$$\frac{3 \tan^2(bx + a) + 1}{3b \tan^3(bx + a)}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(csc(b*x+a)^4,x, algorithm="giac")`

[Out] $-1/3*(3*\tan(b*x + a)^2 + 1)/(b*\tan(b*x + a)^3)$

3.5 $\int \csc^5(a + bx) dx$

Optimal. Leaf size=55

$$-\frac{3 \tanh^{-1}(\cos(a + bx))}{8b} - \frac{\cot(a + bx) \csc^3(a + bx)}{4b} - \frac{3 \cot(a + bx) \csc(a + bx)}{8b}$$

[Out] $(-3*\text{ArcTanh}[\text{Cos}[a + b*x]])/(8*b) - (3*\text{Cot}[a + b*x]*\text{Csc}[a + b*x])/(8*b) - (\text{Cot}[a + b*x]*\text{Csc}[a + b*x]^3)/(4*b)$

Rubi [A] time = 0.0259667, antiderivative size = 55, normalized size of antiderivative = 1., number of steps used = 3, number of rules used = 2, integrand size = 8, $\frac{\text{number of rules}}{\text{integrand size}} = 0.25$, Rules used = {3768, 3770}

$$-\frac{3 \tanh^{-1}(\cos(a + bx))}{8b} - \frac{\cot(a + bx) \csc^3(a + bx)}{4b} - \frac{3 \cot(a + bx) \csc(a + bx)}{8b}$$

Antiderivative was successfully verified.

[In] Int[Csc[a + b*x]^5, x]

[Out] $(-3*\text{ArcTanh}[\text{Cos}[a + b*x]])/(8*b) - (3*\text{Cot}[a + b*x]*\text{Csc}[a + b*x])/(8*b) - (\text{Cot}[a + b*x]*\text{Csc}[a + b*x]^3)/(4*b)$

Rule 3768

Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := -Simp[(b*Csc[c + d*x]*(b*Csc[c + d*x])^(n - 1))/(d*(n - 1)), x] + Dist[(b^2*(n - 2))/(n - 1), Int[(b*Csc[c + d*x])^(n - 2), x], x] /; FreeQ[{b, c, d}, x] && GtQ[n, 1] && IntegerQ[2*n]

Rule 3770

Int[csc[(c_.) + (d_.)*(x_)], x_Symbol] := -Simp[ArcTanh[Cos[c + d*x]]/d, x] /; FreeQ[{c, d}, x]

Rubi steps

$$\begin{aligned}
\int \csc^5(a + bx) dx &= -\frac{\cot(a + bx) \csc^3(a + bx)}{4b} + \frac{3}{4} \int \csc^3(a + bx) dx \\
&= -\frac{3 \cot(a + bx) \csc(a + bx)}{8b} - \frac{\cot(a + bx) \csc^3(a + bx)}{4b} + \frac{3}{8} \int \csc(a + bx) dx \\
&= -\frac{3 \tanh^{-1}(\cos(a + bx))}{8b} - \frac{3 \cot(a + bx) \csc(a + bx)}{8b} - \frac{\cot(a + bx) \csc^3(a + bx)}{4b}
\end{aligned}$$

Mathematica [B] time = 0.0164213, size = 113, normalized size = 2.05

$$-\frac{\csc^4\left(\frac{1}{2}(a + bx)\right)}{64b} - \frac{3 \csc^2\left(\frac{1}{2}(a + bx)\right)}{32b} + \frac{\sec^4\left(\frac{1}{2}(a + bx)\right)}{64b} + \frac{3 \sec^2\left(\frac{1}{2}(a + bx)\right)}{32b} + \frac{3 \log\left(\sin\left(\frac{1}{2}(a + bx)\right)\right)}{8b} - \frac{3 \log\left(\cos\left(\frac{1}{2}(a + bx)\right)\right)}{8b}$$

Antiderivative was successfully verified.

[In] Integrate[Csc[a + b*x]^5,x]

[Out] (-3*Csc[(a + b*x)/2]^2)/(32*b) - Csc[(a + b*x)/2]^4/(64*b) - (3*Log[Cos[(a + b*x)/2]])/(8*b) + (3*Log[Sin[(a + b*x)/2]])/(8*b) + (3*Sec[(a + b*x)/2]^2)/(32*b) + Sec[(a + b*x)/2]^4/(64*b)

Maple [A] time = 0.021, size = 59, normalized size = 1.1

$$-\frac{\cot(bx + a) (\csc(bx + a))^3}{4b} - \frac{3 \csc(bx + a) \cot(bx + a)}{8b} + \frac{3 \ln(\csc(bx + a) - \cot(bx + a))}{8b}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(csc(b*x+a)^5,x)

[Out] -1/4*cot(b*x+a)*csc(b*x+a)^3/b-3/8*cot(b*x+a)*csc(b*x+a)/b+3/8/b*ln(csc(b*x+a)-cot(b*x+a))

Maxima [A] time = 1.06597, size = 96, normalized size = 1.75

$$\frac{2(3 \cos(bx+a)^3 - 5 \cos(bx+a))}{\cos(bx+a)^4 - 2 \cos(bx+a)^2 + 1} - 3 \log(\cos(bx + a) + 1) + 3 \log(\cos(bx + a) - 1)$$

$16b$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^5,x, algorithm="maxima")

[Out] $\frac{1}{16} * (2 * (3 * \cos(b * x + a) ^ 3 - 5 * \cos(b * x + a)) / (\cos(b * x + a) ^ 4 - 2 * \cos(b * x + a) ^ 2 + 1) - 3 * \log(\cos(b * x + a) + 1) + 3 * \log(\cos(b * x + a) - 1)) / b$

Fricas [B] time = 0.492159, size = 313, normalized size = 5.69

$$\frac{6 \cos(bx + a)^3 - 3(\cos(bx + a)^4 - 2 \cos(bx + a)^2 + 1) \log\left(\frac{1}{2} \cos(bx + a) + \frac{1}{2}\right) + 3(\cos(bx + a)^4 - 2 \cos(bx + a)^2 + 1) \log\left(\frac{1}{2} \cos(bx + a) - \frac{1}{2}\right)}{16(b \cos(bx + a)^4 - 2b \cos(bx + a)^2 + b)}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^5,x, algorithm="fricas")

[Out] $\frac{1}{16} * (6 * \cos(b * x + a) ^ 3 - 3 * (\cos(b * x + a) ^ 4 - 2 * \cos(b * x + a) ^ 2 + 1) * \log(1/2 * \cos(b * x + a) + 1/2) + 3 * (\cos(b * x + a) ^ 4 - 2 * \cos(b * x + a) ^ 2 + 1) * \log(-1/2 * \cos(b * x + a) + 1/2) - 10 * \cos(b * x + a)) / (b * \cos(b * x + a) ^ 4 - 2 * b * \cos(b * x + a) ^ 2 + b)$

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \csc^5(a + bx) dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)**5,x)

[Out] Integral(csc(a + b*x)**5, x)

Giac [B] time = 1.28822, size = 186, normalized size = 3.38

$$\frac{\left(\frac{8(\cos(bx+a)-1)}{\cos(bx+a)+1} - \frac{18(\cos(bx+a)-1)^2}{(\cos(bx+a)+1)^2} - 1\right)(\cos(bx+a)+1)^2}{(\cos(bx+a)-1)^2} - \frac{8(\cos(bx+a)-1)}{\cos(bx+a)+1} + \frac{(\cos(bx+a)-1)^2}{(\cos(bx+a)+1)^2} + 12 \log\left(\frac{|-\cos(bx+a)+1|}{|\cos(bx+a)+1|}\right)}{64b}$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(csc(b*x+a)^5,x, algorithm="giac")
```

```
[Out] 1/64*((8*(cos(b*x + a) - 1)/(cos(b*x + a) + 1) - 18*(cos(b*x + a) - 1)^2/(c
os(b*x + a) + 1)^2 - 1)*(cos(b*x + a) + 1)^2/(cos(b*x + a) - 1)^2 - 8*(cos(
b*x + a) - 1)/(cos(b*x + a) + 1) + (cos(b*x + a) - 1)^2/(cos(b*x + a) + 1)^
2 + 12*log(abs(-cos(b*x + a) + 1)/abs(cos(b*x + a) + 1)))/b
```

3.6 $\int \csc^6(a + bx) dx$

Optimal. Leaf size=42

$$\frac{\cot^5(a + bx)}{5b} - \frac{2 \cot^3(a + bx)}{3b} - \frac{\cot(a + bx)}{b}$$

[Out] $-(\text{Cot}[a + b*x]/b) - (2*\text{Cot}[a + b*x]^3)/(3*b) - \text{Cot}[a + b*x]^5/(5*b)$

Rubi [A] time = 0.0139804, antiderivative size = 42, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 1, integrand size = 8, $\frac{\text{number of rules}}{\text{integrand size}} = 0.125$, Rules used = {3767}

$$\frac{\cot^5(a + bx)}{5b} - \frac{2 \cot^3(a + bx)}{3b} - \frac{\cot(a + bx)}{b}$$

Antiderivative was successfully verified.

[In] Int[Csc[a + b*x]^6, x]

[Out] $-(\text{Cot}[a + b*x]/b) - (2*\text{Cot}[a + b*x]^3)/(3*b) - \text{Cot}[a + b*x]^5/(5*b)$

Rule 3767

Int[csc[(c_.) + (d_.)*(x_)]^(n_), x_Symbol] :> -Dist[d^(-1), Subst[Int[ExpandIntegrand[(1 + x^2)^(n/2 - 1), x], x], x, Cot[c + d*x]], x] /; FreeQ[{c, d}, x] && IGtQ[n/2, 0]

Rubi steps

$$\begin{aligned} \int \csc^6(a + bx) dx &= -\frac{\text{Subst}\left(\int (1 + 2x^2 + x^4) dx, x, \cot(a + bx)\right)}{b} \\ &= -\frac{\cot(a + bx)}{b} - \frac{2 \cot^3(a + bx)}{3b} - \frac{\cot^5(a + bx)}{5b} \end{aligned}$$

Mathematica [A] time = 0.0162388, size = 56, normalized size = 1.33

$$-\frac{8 \cot(a + bx)}{15b} - \frac{\cot(a + bx) \csc^4(a + bx)}{5b} - \frac{4 \cot(a + bx) \csc^2(a + bx)}{15b}$$

Antiderivative was successfully verified.

[In] Integrate[Csc[a + b*x]^6,x]

[Out] $(-8*\cot[a + b*x])/(15*b) - (4*\cot[a + b*x]*\csc[a + b*x]^2)/(15*b) - (\cot[a + b*x]*\csc[a + b*x]^4)/(5*b)$

Maple [A] time = 0.02, size = 33, normalized size = 0.8

$$\frac{\cot(bx + a)}{b} \left(-\frac{8}{15} - \frac{(\csc(bx + a))^4}{5} - \frac{4(\csc(bx + a))^2}{15} \right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(csc(b*x+a)^6,x)

[Out] $1/b*(-8/15-1/5*\csc(b*x+a)^4-4/15*\csc(b*x+a)^2)*\cot(b*x+a)$

Maxima [A] time = 1.01335, size = 47, normalized size = 1.12

$$-\frac{15 \tan(bx + a)^4 + 10 \tan(bx + a)^2 + 3}{15 b \tan(bx + a)^5}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^6,x, algorithm="maxima")

[Out] $-1/15*(15*\tan(b*x + a)^4 + 10*\tan(b*x + a)^2 + 3)/(b*\tan(b*x + a)^5)$

Fricas [A] time = 0.452196, size = 166, normalized size = 3.95

$$\frac{8 \cos(bx + a)^5 - 20 \cos(bx + a)^3 + 15 \cos(bx + a)}{15 (b \cos(bx + a)^4 - 2 b \cos(bx + a)^2 + b) \sin(bx + a)}$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(csc(b*x+a)^6,x, algorithm="fricas")
```

```
[Out] -1/15*(8*cos(b*x + a)^5 - 20*cos(b*x + a)^3 + 15*cos(b*x + a))/((b*cos(b*x + a)^4 - 2*b*cos(b*x + a)^2 + b)*sin(b*x + a))
```

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \csc^6(a + bx) dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(csc(b*x+a)**6,x)
```

```
[Out] Integral(csc(a + b*x)**6, x)
```

Giac [A] time = 1.26094, size = 47, normalized size = 1.12

$$\frac{15 \tan^4(bx + a) + 10 \tan^2(bx + a) + 3}{15 b \tan^5(bx + a)}$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(csc(b*x+a)^6,x, algorithm="giac")
```

```
[Out] -1/15*(15*tan(b*x + a)^4 + 10*tan(b*x + a)^2 + 3)/(b*tan(b*x + a)^5)
```

3.7 $\int \csc^7(a + bx) dx$

Optimal. Leaf size=76

$$\frac{5 \tanh^{-1}(\cos(a + bx))}{16b} - \frac{\cot(a + bx) \csc^5(a + bx)}{6b} - \frac{5 \cot(a + bx) \csc^3(a + bx)}{24b} - \frac{5 \cot(a + bx) \csc(a + bx)}{16b}$$

[Out] (-5*ArcTanh[Cos[a + b*x]])/(16*b) - (5*Cot[a + b*x]*Csc[a + b*x])/(16*b) - (5*Cot[a + b*x]*Csc[a + b*x]^3)/(24*b) - (Cot[a + b*x]*Csc[a + b*x]^5)/(6*b)

Rubi [A] time = 0.0363369, antiderivative size = 76, normalized size of antiderivative = 1., number of steps used = 4, number of rules used = 2, integrand size = 8, $\frac{\text{number of rules}}{\text{integrand size}} = 0.25$, Rules used = {3768, 3770}

$$\frac{5 \tanh^{-1}(\cos(a + bx))}{16b} - \frac{\cot(a + bx) \csc^5(a + bx)}{6b} - \frac{5 \cot(a + bx) \csc^3(a + bx)}{24b} - \frac{5 \cot(a + bx) \csc(a + bx)}{16b}$$

Antiderivative was successfully verified.

[In] Int[Csc[a + b*x]^7,x]

[Out] (-5*ArcTanh[Cos[a + b*x]])/(16*b) - (5*Cot[a + b*x]*Csc[a + b*x])/(16*b) - (5*Cot[a + b*x]*Csc[a + b*x]^3)/(24*b) - (Cot[a + b*x]*Csc[a + b*x]^5)/(6*b)

Rule 3768

Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^n], x_Symbol] := -Simp[(b*Csc[c + d*x] * (b*Csc[c + d*x])^(n - 1))/(d*(n - 1)), x] + Dist[(b^2*(n - 2))/(n - 1), Int[(b*Csc[c + d*x])^(n - 2), x], x] /; FreeQ[{b, c, d}, x] && GtQ[n, 1] && IntegerQ[2*n]

Rule 3770

Int[csc[(c_.) + (d_.)*(x_)], x_Symbol] := -Simp[ArcTanh[Cos[c + d*x]]/d, x] /; FreeQ[{c, d}, x]

Rubi steps

$$\begin{aligned}
\int \csc^7(a+bx) dx &= -\frac{\cot(a+bx) \csc^5(a+bx)}{6b} + \frac{5}{6} \int \csc^5(a+bx) dx \\
&= -\frac{5 \cot(a+bx) \csc^3(a+bx)}{24b} - \frac{\cot(a+bx) \csc^5(a+bx)}{6b} + \frac{5}{8} \int \csc^3(a+bx) dx \\
&= -\frac{5 \cot(a+bx) \csc(a+bx)}{16b} - \frac{5 \cot(a+bx) \csc^3(a+bx)}{24b} - \frac{\cot(a+bx) \csc^5(a+bx)}{6b} + \frac{5}{16} \int \csc(a+bx) dx \\
&= -\frac{5 \tanh^{-1}(\cos(a+bx))}{16b} - \frac{5 \cot(a+bx) \csc(a+bx)}{16b} - \frac{5 \cot(a+bx) \csc^3(a+bx)}{24b} - \frac{\cot(a+bx) \csc^5(a+bx)}{6b}
\end{aligned}$$

Mathematica [A] time = 0.013899, size = 151, normalized size = 1.99

$$-\frac{\csc^6\left(\frac{1}{2}(a+bx)\right)}{384b} - \frac{\csc^4\left(\frac{1}{2}(a+bx)\right)}{64b} - \frac{5 \csc^2\left(\frac{1}{2}(a+bx)\right)}{64b} + \frac{\sec^6\left(\frac{1}{2}(a+bx)\right)}{384b} + \frac{\sec^4\left(\frac{1}{2}(a+bx)\right)}{64b} + \frac{5 \sec^2\left(\frac{1}{2}(a+bx)\right)}{64b}$$

Antiderivative was successfully verified.

[In] Integrate[Csc[a + b*x]^7,x]

[Out] $(-5*\text{Csc}[(a + b*x)/2]^2)/(64*b) - \text{Csc}[(a + b*x)/2]^4/(64*b) - \text{Csc}[(a + b*x)/2]^6/(384*b) - (5*\text{Log}[\text{Cos}[(a + b*x)/2]])/(16*b) + (5*\text{Log}[\text{Sin}[(a + b*x)/2]])/(16*b) + (5*\text{Sec}[(a + b*x)/2]^2)/(64*b) + \text{Sec}[(a + b*x)/2]^4/(64*b) + \text{Sec}[(a + b*x)/2]^6/(384*b)$

Maple [A] time = 0.022, size = 78, normalized size = 1.

$$-\frac{\cot(bx+a) (\csc(bx+a))^5}{6b} - \frac{5 \cot(bx+a) (\csc(bx+a))^3}{24b} - \frac{5 \csc(bx+a) \cot(bx+a)}{16b} + \frac{5 \ln(\csc(bx+a) - \cot(bx+a))}{16b}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(csc(b*x+a)^7,x)

[Out] $-1/6*\cot(b*x+a)*\csc(b*x+a)^5/b-5/24*\cot(b*x+a)*\csc(b*x+a)^3/b-5/16*\cot(b*x+a)*\csc(b*x+a)/b+5/16/b*\ln(\csc(b*x+a)-\cot(b*x+a))$

Maxima [A] time = 1.04107, size = 123, normalized size = 1.62

$$\frac{2(15 \cos(bx+a)^5 - 40 \cos(bx+a)^3 + 33 \cos(bx+a)) - 15 \log(\cos(bx+a) + 1) + 15 \log(\cos(bx+a) - 1)}{\cos(bx+a)^6 - 3 \cos(bx+a)^4 + 3 \cos(bx+a)^2 - 1} \cdot \frac{1}{96b}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^7,x, algorithm="maxima")

[Out] 1/96*(2*(15*cos(b*x + a)^5 - 40*cos(b*x + a)^3 + 33*cos(b*x + a))/(cos(b*x + a)^6 - 3*cos(b*x + a)^4 + 3*cos(b*x + a)^2 - 1) - 15*log(cos(b*x + a) + 1) + 15*log(cos(b*x + a) - 1))/b

Fricas [B] time = 0.497951, size = 424, normalized size = 5.58

$$\frac{30 \cos(bx+a)^5 - 80 \cos(bx+a)^3 - 15(\cos(bx+a)^6 - 3 \cos(bx+a)^4 + 3 \cos(bx+a)^2 - 1) \log\left(\frac{1}{2} \cos(bx+a) + \frac{1}{2}\right) - 15(\cos(bx+a)^6 - 3 \cos(bx+a)^4 + 3 \cos(bx+a)^2 - 1) \log\left(\frac{1}{2} \cos(bx+a) - \frac{1}{2}\right)}{96(b \cos(bx+a)^6 - 3b \cos(bx+a)^4 + 3b \cos(bx+a)^2 - b)}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^7,x, algorithm="fricas")

[Out] 1/96*(30*cos(b*x + a)^5 - 80*cos(b*x + a)^3 - 15*(cos(b*x + a)^6 - 3*cos(b*x + a)^4 + 3*cos(b*x + a)^2 - 1)*log(1/2*cos(b*x + a) + 1/2) + 15*(cos(b*x + a)^6 - 3*cos(b*x + a)^4 + 3*cos(b*x + a)^2 - 1)*log(-1/2*cos(b*x + a) + 1/2) + 66*cos(b*x + a))/(b*cos(b*x + a)^6 - 3*b*cos(b*x + a)^4 + 3*b*cos(b*x + a)^2 - b)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \csc^7(a + bx) dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)**7,x)

[Out] Integral(csc(a + b*x)**7, x)

Giac [B] time = 1.29354, size = 246, normalized size = 3.24

$$\frac{\left(\frac{9(\cos(bx+a)-1)}{\cos(bx+a)+1} - \frac{45(\cos(bx+a)-1)^2}{(\cos(bx+a)+1)^2} + \frac{110(\cos(bx+a)-1)^3}{(\cos(bx+a)+1)^3} - 1\right)(\cos(bx+a)+1)^3}{(\cos(bx+a)-1)^3} + \frac{45(\cos(bx+a)-1)}{\cos(bx+a)+1} - \frac{9(\cos(bx+a)-1)^2}{(\cos(bx+a)+1)^2} + \frac{(\cos(bx+a)-1)^3}{(\cos(bx+a)+1)^3} - 60 \log\left(\frac{|\cos(bx+a)-1|}{|\cos(bx+a)+1|}\right)$$

$384b$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^7,x, algorithm="giac")

[Out]
$$\frac{-1/384 * ((9 * (\cos(b*x + a) - 1) / (\cos(b*x + a) + 1) - 45 * (\cos(b*x + a) - 1)^2 / (\cos(b*x + a) + 1)^2 + 110 * (\cos(b*x + a) - 1)^3 / (\cos(b*x + a) + 1)^3 - 1) * (\cos(b*x + a) + 1)^3 / (\cos(b*x + a) - 1)^3 + 45 * (\cos(b*x + a) - 1) / (\cos(b*x + a) + 1) - 9 * (\cos(b*x + a) - 1)^2 / (\cos(b*x + a) + 1)^2 + (\cos(b*x + a) - 1)^3 / (\cos(b*x + a) + 1)^3 - 60 * \log(\text{abs}(-\cos(b*x + a) + 1) / \text{abs}(\cos(b*x + a) + 1)))}{b}$$

3.8 $\int \csc^8(a + bx) dx$

Optimal. Leaf size=55

$$-\frac{\cot^7(a + bx)}{7b} - \frac{3 \cot^5(a + bx)}{5b} - \frac{\cot^3(a + bx)}{b} - \frac{\cot(a + bx)}{b}$$

[Out] $-(\text{Cot}[a + b*x]/b) - \text{Cot}[a + b*x]^3/b - (3*\text{Cot}[a + b*x]^5)/(5*b) - \text{Cot}[a + b*x]^7/(7*b)$

Rubi [A] time = 0.0165351, antiderivative size = 55, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 1, integrand size = 8, $\frac{\text{number of rules}}{\text{integrand size}} = 0.125$, Rules used = {3767}

$$-\frac{\cot^7(a + bx)}{7b} - \frac{3 \cot^5(a + bx)}{5b} - \frac{\cot^3(a + bx)}{b} - \frac{\cot(a + bx)}{b}$$

Antiderivative was successfully verified.

[In] $\text{Int}[\text{Csc}[a + b*x]^8, x]$

[Out] $-(\text{Cot}[a + b*x]/b) - \text{Cot}[a + b*x]^3/b - (3*\text{Cot}[a + b*x]^5)/(5*b) - \text{Cot}[a + b*x]^7/(7*b)$

Rule 3767

$\text{Int}[\text{csc}[(c_.) + (d_.)*(x_.)]^{(n_.)}, x_Symbol] \rightarrow -\text{Dist}[d^{(-1)}, \text{Subst}[\text{Int}[\text{ExpandIntegrand}[(1 + x^2)^{(n/2 - 1)}, x], x], x, \text{Cot}[c + d*x]], x] /;$ $\text{FreeQ}\{c, d\}, x \&\& \text{IGtQ}[n/2, 0]$

Rubi steps

$$\begin{aligned} \int \csc^8(a + bx) dx &= -\frac{\text{Subst}\left(\int (1 + 3x^2 + 3x^4 + x^6) dx, x, \cot(a + bx)\right)}{b} \\ &= -\frac{\cot(a + bx)}{b} - \frac{\cot^3(a + bx)}{b} - \frac{3 \cot^5(a + bx)}{5b} - \frac{\cot^7(a + bx)}{7b} \end{aligned}$$

Mathematica [A] time = 0.0107059, size = 77, normalized size = 1.4

$$-\frac{16 \cot(a + bx)}{35b} - \frac{\cot(a + bx) \csc^6(a + bx)}{7b} - \frac{6 \cot(a + bx) \csc^4(a + bx)}{35b} - \frac{8 \cot(a + bx) \csc^2(a + bx)}{35b}$$

Antiderivative was successfully verified.

[In] Integrate[Csc[a + b*x]^8,x]

[Out] $(-16*\cot[a + b*x])/(35*b) - (8*\cot[a + b*x]*\csc[a + b*x]^2)/(35*b) - (6*\cot[a + b*x]*\csc[a + b*x]^4)/(35*b) - (\cot[a + b*x]*\csc[a + b*x]^6)/(7*b)$

Maple [A] time = 0.02, size = 43, normalized size = 0.8

$$\frac{\cot(bx + a)}{b} \left(-\frac{16}{35} - \frac{(\csc(bx + a))^6}{7} - \frac{6(\csc(bx + a))^4}{35} - \frac{8(\csc(bx + a))^2}{35} \right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(csc(b*x+a)^8,x)

[Out] $1/b*(-16/35-1/7*\csc(b*x+a)^6-6/35*\csc(b*x+a)^4-8/35*\csc(b*x+a)^2)*\cot(b*x+a)$

Maxima [A] time = 1.01128, size = 61, normalized size = 1.11

$$-\frac{35 \tan(bx + a)^6 + 35 \tan(bx + a)^4 + 21 \tan(bx + a)^2 + 5}{35 b \tan(bx + a)^7}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^8,x, algorithm="maxima")

[Out] $-1/35*(35*\tan(b*x + a)^6 + 35*\tan(b*x + a)^4 + 21*\tan(b*x + a)^2 + 5)/(b*\tan(b*x + a)^7)$

Fricas [A] time = 0.460868, size = 223, normalized size = 4.05

$$-\frac{16 \cos(bx + a)^7 - 56 \cos(bx + a)^5 + 70 \cos(bx + a)^3 - 35 \cos(bx + a)}{35 (b \cos(bx + a)^6 - 3 b \cos(bx + a)^4 + 3 b \cos(bx + a)^2 - b) \sin(bx + a)}$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(csc(b*x+a)^8,x, algorithm="fricas")
```

```
[Out] -1/35*(16*cos(b*x + a)^7 - 56*cos(b*x + a)^5 + 70*cos(b*x + a)^3 - 35*cos(b
*x + a))/((b*cos(b*x + a)^6 - 3*b*cos(b*x + a)^4 + 3*b*cos(b*x + a)^2 - b)*
sin(b*x + a))
```

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \csc^8(a + bx) dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(csc(b*x+a)**8,x)
```

```
[Out] Integral(csc(a + b*x)**8, x)
```

Giac [A] time = 1.22946, size = 61, normalized size = 1.11

$$\frac{35 \tan^6(bx + a) + 35 \tan^4(bx + a) + 21 \tan^2(bx + a) + 5}{35 b \tan^7(bx + a)}$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(csc(b*x+a)^8,x, algorithm="giac")
```

```
[Out] -1/35*(35*tan(b*x + a)^6 + 35*tan(b*x + a)^4 + 21*tan(b*x + a)^2 + 5)/(b*ta
n(b*x + a)^7)
```

3.9 $\int \csc^{\frac{7}{2}}(a + bx) dx$

Optimal. Leaf size=90

$$\frac{2 \cos(a + bx) \csc^{\frac{5}{2}}(a + bx)}{5b} - \frac{6 \cos(a + bx) \sqrt{\csc(a + bx)}}{5b} - \frac{6 \sqrt{\sin(a + bx)} \sqrt{\csc(a + bx)} E\left(\frac{1}{2}\left(a + bx - \frac{\pi}{2}\right) \middle| 2\right)}{5b}$$

[Out] $(-6*\text{Cos}[a + b*x]*\text{Sqrt}[\text{Csc}[a + b*x]])/(5*b) - (2*\text{Cos}[a + b*x]*\text{Csc}[a + b*x]^{(5/2)})/(5*b) - (6*\text{Sqrt}[\text{Csc}[a + b*x]]*\text{EllipticE}[(a - \text{Pi}/2 + b*x)/2, 2]*\text{Sqrt}[\text{Sin}[a + b*x]])/(5*b)$

Rubi [A] time = 0.0367819, antiderivative size = 90, normalized size of antiderivative = 1., number of steps used = 4, number of rules used = 3, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.3$, Rules used = {3768, 3771, 2639}

$$\frac{2 \cos(a + bx) \csc^{\frac{5}{2}}(a + bx)}{5b} - \frac{6 \cos(a + bx) \sqrt{\csc(a + bx)}}{5b} - \frac{6 \sqrt{\sin(a + bx)} \sqrt{\csc(a + bx)} E\left(\frac{1}{2}\left(a + bx - \frac{\pi}{2}\right) \middle| 2\right)}{5b}$$

Antiderivative was successfully verified.

[In] $\text{Int}[\text{Csc}[a + b*x]^{(7/2)}, x]$

[Out] $(-6*\text{Cos}[a + b*x]*\text{Sqrt}[\text{Csc}[a + b*x]])/(5*b) - (2*\text{Cos}[a + b*x]*\text{Csc}[a + b*x]^{(5/2)})/(5*b) - (6*\text{Sqrt}[\text{Csc}[a + b*x]]*\text{EllipticE}[(a - \text{Pi}/2 + b*x)/2, 2]*\text{Sqrt}[\text{Sin}[a + b*x]])/(5*b)$

Rule 3768

$\text{Int}[(\text{csc}[(c_.) + (d_.)*(x_.)]*(b_.))^{(n_.)}, x_Symbol] \rightarrow -\text{Simp}[(b*\text{Cos}[c + d*x])*(b*\text{Csc}[c + d*x])^{(n - 1)})/(d*(n - 1)), x] + \text{Dist}[(b^2*(n - 2))/(n - 1), \text{Int}[(b*\text{Csc}[c + d*x])^{(n - 2)}, x], x] /;$ FreeQ[{b, c, d}, x] && GtQ[n, 1] && IntegerQ[2*n]

Rule 3771

$\text{Int}[(\text{csc}[(c_.) + (d_.)*(x_.)]*(b_.))^{(n_.)}, x_Symbol] \rightarrow \text{Dist}[(b*\text{Csc}[c + d*x])^{n-1}*\text{Sin}[c + d*x]^n, \text{Int}[1/\text{Sin}[c + d*x]^n, x], x] /;$ FreeQ[{b, c, d}, x] && EqQ[n^2, 1/4]

Rule 2639

```
Int[Sqrt[sin[(c_.) + (d_.)*(x_.)], x_Symbol] := Simp[(2*EllipticE[(1*(c - P
i/2 + d*x))/2, 2])/d, x] /; FreeQ[{c, d}, x]
```

Rubi steps

$$\begin{aligned} \int \csc^{\frac{7}{2}}(a+bx) dx &= -\frac{2 \cos(a+bx) \csc^{\frac{5}{2}}(a+bx)}{5b} + \frac{3}{5} \int \csc^{\frac{3}{2}}(a+bx) dx \\ &= -\frac{6 \cos(a+bx) \sqrt{\csc(a+bx)}}{5b} - \frac{2 \cos(a+bx) \csc^{\frac{5}{2}}(a+bx)}{5b} - \frac{3}{5} \int \frac{1}{\sqrt{\csc(a+bx)}} dx \\ &= -\frac{6 \cos(a+bx) \sqrt{\csc(a+bx)}}{5b} - \frac{2 \cos(a+bx) \csc^{\frac{5}{2}}(a+bx)}{5b} - \frac{1}{5} (3\sqrt{\csc(a+bx)}\sqrt{\sin(a+bx)}) \int \sqrt{\sin} \\ &= -\frac{6 \cos(a+bx) \sqrt{\csc(a+bx)}}{5b} - \frac{2 \cos(a+bx) \csc^{\frac{5}{2}}(a+bx)}{5b} - \frac{6\sqrt{\csc(a+bx)}E\left(\frac{1}{2}\left(a - \frac{\pi}{2} + bx\right)\middle|2\right)}{5b} \sqrt{\sin} \end{aligned}$$

Mathematica [A] time = 0.200648, size = 63, normalized size = 0.7

$$\frac{\csc^{\frac{5}{2}}(a+bx) \left(-7 \cos(a+bx) + 3 \cos(3(a+bx)) + 12 \sin^{\frac{5}{2}}(a+bx) E\left(\frac{1}{4}(-2a - 2bx + \pi)\middle|2\right) \right)}{10b}$$

Antiderivative was successfully verified.

```
[In] Integrate[Csc[a + b*x]^(7/2), x]
```

```
[Out] (Csc[a + b*x]^(5/2)*(-7*Cos[a + b*x] + 3*Cos[3*(a + b*x)] + 12*EllipticE[(-
2*a + Pi - 2*b*x)/4, 2]*Sin[a + b*x]^(5/2)))/(10*b)
```

Maple [A] time = 1.171, size = 160, normalized size = 1.8

$$\frac{1}{5 \cos(bx+a)b} \left(6 \sqrt{\sin(bx+a)+1} \sqrt{-2 \sin(bx+a)+2} \sqrt{-\sin(bx+a)} (\sin(bx+a))^2 \text{EllipticE}\left(\sqrt{\sin(bx+a)+1}, 1/2\right) \right)$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] int(csc(b*x+a)^(7/2), x)
```

```
[Out] 1/5/sin(b*x+a)^(5/2)*(6*(sin(b*x+a)+1)^(1/2)*(-2*sin(b*x+a)+2)^(1/2)*(-sin(
b*x+a))^(1/2)*sin(b*x+a)^2*EllipticE((sin(b*x+a)+1)^(1/2), 1/2*2^(1/2))-3*(s
```

$$\frac{\sin(bx+a)+1)^{1/2}*(-2*\sin(bx+a)+2)^{1/2}*(-\sin(bx+a))^{1/2}*\sin(bx+a)^2 * \text{EllipticF}((\sin(bx+a)+1)^{1/2}, 1/2*2^{1/2})+6*\sin(bx+a)^4-4*\sin(bx+a)^2-2)/\cos(bx+a)/b}$$

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \csc(bx + a)^{7/2} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^(7/2),x, algorithm="maxima")

[Out] integrate(csc(b*x + a)^(7/2), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\csc(bx + a)^{7/2}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^(7/2),x, algorithm="fricas")

[Out] integral(csc(b*x + a)^(7/2), x)

Sympy [F(-1)] time = 0., size = 0, normalized size = 0.

Timed out

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)**(7/2),x)

[Out] Timed out

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \csc(bx + a)^{\frac{7}{2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(csc(b*x+a)^(7/2),x, algorithm="giac")
```

```
[Out] integrate(csc(b*x + a)^(7/2), x)
```


3.10 $\int \csc^{\frac{5}{2}}(a + bx) dx$

Optimal. Leaf size=67

$$\frac{2\sqrt{\sin(a+bx)}\sqrt{\csc(a+bx)}\text{EllipticF}\left(\frac{1}{2}\left(a+bx-\frac{\pi}{2}\right), 2\right)}{3b} - \frac{2\cos(a+bx)\csc^{\frac{3}{2}}(a+bx)}{3b}$$

[Out] $(-2*\text{Cos}[a + b*x]*\text{Csc}[a + b*x]^{(3/2)})/(3*b) + (2*\text{Sqrt}[\text{Csc}[a + b*x]]*\text{EllipticF}[(a - \text{Pi}/2 + b*x)/2, 2]*\text{Sqrt}[\text{Sin}[a + b*x]])/(3*b)$

Rubi [A] time = 0.0260246, antiderivative size = 67, normalized size of antiderivative = 1., number of steps used = 3, number of rules used = 3, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.3$, Rules used = {3768, 3771, 2641}

$$\frac{2\sqrt{\sin(a+bx)}\sqrt{\csc(a+bx)}F\left(\frac{1}{2}\left(a+bx-\frac{\pi}{2}\right)\middle|2\right)}{3b} - \frac{2\cos(a+bx)\csc^{\frac{3}{2}}(a+bx)}{3b}$$

Antiderivative was successfully verified.

[In] $\text{Int}[\text{Csc}[a + b*x]^{(5/2)}, x]$

[Out] $(-2*\text{Cos}[a + b*x]*\text{Csc}[a + b*x]^{(3/2)})/(3*b) + (2*\text{Sqrt}[\text{Csc}[a + b*x]]*\text{EllipticF}[(a - \text{Pi}/2 + b*x)/2, 2]*\text{Sqrt}[\text{Sin}[a + b*x]])/(3*b)$

Rule 3768

$\text{Int}[(\text{csc}[(c_.) + (d_.)*(x_.)]*(b_.))^{(n_.)}, x_Symbol] \text{ :> } -\text{Simp}[(b*\text{Cos}[c + d*x])*(b*\text{Csc}[c + d*x])^{(n-1)})/(d*(n-1)), x] + \text{Dist}[(b^2*(n-2))/(n-1), \text{Int}[(b*\text{Csc}[c + d*x])^{(n-2)}, x], x] \text{ /; FreeQ}\{b, c, d, x\} \ \&\amp; \ \text{GtQ}[n, 1] \ \&\amp; \ \text{IntegerQ}[2*n]$

Rule 3771

$\text{Int}[(\text{csc}[(c_.) + (d_.)*(x_.)]*(b_.))^{(n_.)}, x_Symbol] \text{ :> } \text{Dist}[(b*\text{Csc}[c + d*x])^{n-1}*\text{Sin}[c + d*x]^n, \text{Int}[1/\text{Sin}[c + d*x]^n, x], x] \text{ /; FreeQ}\{b, c, d, x\} \ \&\amp; \ \text{EqQ}[n^2, 1/4]$

Rule 2641

```
Int[1/Sqrt[sin[(c_.) + (d_.)*(x_)]], x_Symbol] :> Simp[(2*EllipticF[(1*(c - Pi/2 + d*x))/2, 2])/d, x] /; FreeQ[{c, d}, x]
```

Rubi steps

$$\begin{aligned} \int \csc^{\frac{5}{2}}(a + bx) dx &= -\frac{2 \cos(a + bx) \csc^{\frac{3}{2}}(a + bx)}{3b} + \frac{1}{3} \int \sqrt{\csc(a + bx)} dx \\ &= -\frac{2 \cos(a + bx) \csc^{\frac{3}{2}}(a + bx)}{3b} + \frac{1}{3} \left(\sqrt{\csc(a + bx)} \sqrt{\sin(a + bx)} \right) \int \frac{1}{\sqrt{\sin(a + bx)}} dx \\ &= -\frac{2 \cos(a + bx) \csc^{\frac{3}{2}}(a + bx)}{3b} + \frac{2\sqrt{\csc(a + bx)} F\left(\frac{1}{2}\left(a - \frac{\pi}{2} + bx\right) \middle| 2\right) \sqrt{\sin(a + bx)}}{3b} \end{aligned}$$

Mathematica [A] time = 0.08119, size = 50, normalized size = 0.75

$$\frac{2 \csc^{\frac{3}{2}}(a + bx) \left(\sin^{\frac{3}{2}}(a + bx) \text{EllipticF}\left(\frac{1}{4}(-2a - 2bx + \pi), 2\right) + \cos(a + bx) \right)}{3b}$$

Antiderivative was successfully verified.

```
[In] Integrate[Csc[a + b*x]^(5/2), x]
```

```
[Out] (-2*Csc[a + b*x]^(3/2)*(Cos[a + b*x] + EllipticF[(-2*a + Pi - 2*b*x)/4, 2]*Sin[a + b*x]^(3/2)))/(3*b)
```

Maple [A] time = 1.2, size = 88, normalized size = 1.3

$$\frac{1}{3 \cos(bx + a) b} \left(\sqrt{\sin(bx + a) + 1} \sqrt{-2 \sin(bx + a) + 2} \sqrt{-\sin(bx + a)} \text{EllipticF}\left(\sqrt{\sin(bx + a) + 1}, \frac{\sqrt{2}}{2}\right) \sin(bx + a) - \right.$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] int(csc(b*x+a)^(5/2), x)
```

```
[Out] 1/3/sin(b*x+a)^(3/2)*((sin(b*x+a)+1)^(1/2)*(-2*sin(b*x+a)+2)^(1/2)*(-sin(b*x+a))^(1/2)*EllipticF((sin(b*x+a)+1)^(1/2), 1/2*2^(1/2))*sin(b*x+a)-2*cos(b*
```

$x+a)^2)/\cos(b*x+a)/b$

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \csc(bx + a)^{\frac{5}{2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^(5/2),x, algorithm="maxima")

[Out] integrate(csc(b*x + a)^(5/2), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\csc(bx + a)^{\frac{5}{2}}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^(5/2),x, algorithm="fricas")

[Out] integral(csc(b*x + a)^(5/2), x)

Sympy [F(-1)] time = 0., size = 0, normalized size = 0.

Timed out

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)**(5/2),x)

[Out] Timed out

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \csc(bx + a)^{\frac{5}{2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(csc(b*x+a)^(5/2),x, algorithm="giac")
```

```
[Out] integrate(csc(b*x + a)^(5/2), x)
```

3.11 $\int \csc^{\frac{3}{2}}(a + bx) dx$

Optimal. Leaf size=63

$$-\frac{2 \cos(a + bx) \sqrt{\csc(a + bx)}}{b} - \frac{2 \sqrt{\sin(a + bx)} \sqrt{\csc(a + bx)} E\left(\frac{1}{2} \left(a + bx - \frac{\pi}{2}\right) \middle| 2\right)}{b}$$

[Out] $(-2*\text{Cos}[a + b*x]*\text{Sqrt}[\text{Csc}[a + b*x]])/b - (2*\text{Sqrt}[\text{Csc}[a + b*x]]*\text{EllipticE}[(a - \text{Pi}/2 + b*x)/2, 2]*\text{Sqrt}[\text{Sin}[a + b*x]])/b$

Rubi [A] time = 0.0243478, antiderivative size = 63, normalized size of antiderivative = 1., number of steps used = 3, number of rules used = 3, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.3$, Rules used = {3768, 3771, 2639}

$$-\frac{2 \cos(a + bx) \sqrt{\csc(a + bx)}}{b} - \frac{2 \sqrt{\sin(a + bx)} \sqrt{\csc(a + bx)} E\left(\frac{1}{2} \left(a + bx - \frac{\pi}{2}\right) \middle| 2\right)}{b}$$

Antiderivative was successfully verified.

[In] $\text{Int}[\text{Csc}[a + b*x]^{(3/2)}, x]$

[Out] $(-2*\text{Cos}[a + b*x]*\text{Sqrt}[\text{Csc}[a + b*x]])/b - (2*\text{Sqrt}[\text{Csc}[a + b*x]]*\text{EllipticE}[(a - \text{Pi}/2 + b*x)/2, 2]*\text{Sqrt}[\text{Sin}[a + b*x]])/b$

Rule 3768

$\text{Int}[(\text{csc}[(c_.) + (d_.)(x_)]*(b_.))^{(n_.)}, x_Symbol] \text{ :> } -\text{Simp}[(b*\text{Cos}[c + d*x] * (b*\text{Csc}[c + d*x])^{(n - 1)})/(d*(n - 1)), x] + \text{Dist}[(b^{2*(n - 2)})/(n - 1), \text{Int}[(b*\text{Csc}[c + d*x])^{(n - 2)}, x], x] \text{ /; FreeQ}\{b, c, d, x\} \ \&\& \ \text{GtQ}\{n, 1\} \ \&\& \ \text{IntegerQ}\{2*n\}$

Rule 3771

$\text{Int}[(\text{csc}[(c_.) + (d_.)(x_)]*(b_.))^{(n_.)}, x_Symbol] \text{ :> } \text{Dist}[(b*\text{Csc}[c + d*x])^{n} * \text{Sin}[c + d*x]^{n}, \text{Int}[1/\text{Sin}[c + d*x]^{n}, x], x] \text{ /; FreeQ}\{b, c, d, x\} \ \&\& \ \text{EqQ}\{n^2, 1/4\}$

Rule 2639

```
Int[Sqrt[sin[(c_.) + (d_.)*(x_)]], x_Symbol] := Simp[(2*EllipticE[(1*(c - P
i/2 + d*x))/2, 2])/d, x] /; FreeQ[{c, d}, x]
```

Rubi steps

$$\begin{aligned} \int \csc^{\frac{3}{2}}(a + bx) dx &= -\frac{2 \cos(a + bx) \sqrt{\csc(a + bx)}}{b} - \int \frac{1}{\sqrt{\csc(a + bx)}} dx \\ &= -\frac{2 \cos(a + bx) \sqrt{\csc(a + bx)}}{b} - (\sqrt{\csc(a + bx)} \sqrt{\sin(a + bx)}) \int \sqrt{\sin(a + bx)} dx \\ &= -\frac{2 \cos(a + bx) \sqrt{\csc(a + bx)}}{b} - \frac{2 \sqrt{\csc(a + bx)} E\left(\frac{1}{2} \left(a - \frac{\pi}{2} + bx\right) \middle| 2\right) \sqrt{\sin(a + bx)}}{b} \end{aligned}$$

Mathematica [A] time = 0.058019, size = 49, normalized size = 0.78

$$-\frac{2\sqrt{\csc(a+bx)}\left(\cos(a+bx) - \sqrt{\sin(a+bx)}E\left(\frac{1}{4}(-2a-2bx+\pi)\middle|2\right)\right)}{b}$$

Antiderivative was successfully verified.

```
[In] Integrate[Csc[a + b*x]^(3/2), x]
```

```
[Out] (-2*Sqrt[Csc[a + b*x]]*(Cos[a + b*x] - EllipticE[(-2*a + Pi - 2*b*x)/4, 2]*
Sqrt[Sin[a + b*x]]))/b
```

Maple [A] time = 1.344, size = 132, normalized size = 2.1

$$\frac{1}{\cos(bx + a)b} \left(-\sqrt{\sin(bx + a) + 1} \sqrt{-2 \sin(bx + a) + 2} \sqrt{-\sin(bx + a)} \text{EllipticF} \left(\sqrt{\sin(bx + a) + 1}, \frac{\sqrt{2}}{2} \right) + 2 \sqrt{\sin(bx + a)} \right)$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] int(csc(b*x+a)^(3/2), x)
```

```
[Out] (-sin(b*x+a)+1)^(1/2)*(-2*sin(b*x+a)+2)^(1/2)*(-sin(b*x+a))^(1/2)*Elliptic
F((sin(b*x+a)+1)^(1/2), 1/2*2^(1/2))+2*(sin(b*x+a)+1)^(1/2)*(-2*sin(b*x+a)+2
)^(1/2)*(-sin(b*x+a))^(1/2)*EllipticE((sin(b*x+a)+1)^(1/2), 1/2*2^(1/2))-2*c
```

$\cos(b*x+a)^2/\cos(b*x+a)/\sin(b*x+a)^{(1/2)}/b$

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \csc(bx + a)^{\frac{3}{2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^(3/2),x, algorithm="maxima")

[Out] integrate(csc(b*x + a)^(3/2), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\csc(bx + a)^{\frac{3}{2}}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^(3/2),x, algorithm="fricas")

[Out] integral(csc(b*x + a)^(3/2), x)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \csc^{\frac{3}{2}}(a + bx) dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)**(3/2),x)

[Out] Integral(csc(a + b*x)**(3/2), x)

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \csc(bx + a)^{\frac{3}{2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(csc(b*x+a)^(3/2),x, algorithm="giac")
```

```
[Out] integrate(csc(b*x + a)^(3/2), x)
```


3.12 $\int \sqrt{\csc(a + bx)} dx$

Optimal. Leaf size=41

$$\frac{2\sqrt{\sin(a + bx)}\sqrt{\csc(a + bx)}\text{EllipticF}\left(\frac{1}{2}\left(a + bx - \frac{\pi}{2}\right), 2\right)}{b}$$

[Out] (2*Sqrt[Csc[a + b*x]]*EllipticF[(a - Pi/2 + b*x)/2, 2]*Sqrt[Sin[a + b*x]])/b

Rubi [A] time = 0.0166098, antiderivative size = 41, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.2$, Rules used = {3771, 2641}

$$\frac{2\sqrt{\sin(a + bx)}\sqrt{\csc(a + bx)}F\left(\frac{1}{2}\left(a + bx - \frac{\pi}{2}\right)\middle|2\right)}{b}$$

Antiderivative was successfully verified.

[In] Int[Sqrt[Csc[a + b*x]], x]

[Out] (2*Sqrt[Csc[a + b*x]]*EllipticF[(a - Pi/2 + b*x)/2, 2]*Sqrt[Sin[a + b*x]])/b

Rule 3771

Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] :> Dist[(b*Csc[c + d*x])^n*Sin[c + d*x]^n, Int[1/Sin[c + d*x]^n, x], x] /; FreeQ[{b, c, d}, x] && EqQ[n^2, 1/4]

Rule 2641

Int[1/Sqrt[sin[(c_.) + (d_.)*(x_)]], x_Symbol] :> Simp[(2*EllipticF[(1*(c - Pi/2 + d*x))/2, 2])/d, x] /; FreeQ[{c, d}, x]

Rubi steps

$$\int \sqrt{\csc(a+bx)} dx = (\sqrt{\csc(a+bx)}\sqrt{\sin(a+bx)}) \int \frac{1}{\sqrt{\sin(a+bx)}} dx$$

$$= \frac{2\sqrt{\csc(a+bx)}F\left(\frac{1}{2}\left(a - \frac{\pi}{2} + bx\right)\middle|2\right)\sqrt{\sin(a+bx)}}{b}$$

Mathematica [A] time = 0.0342003, size = 40, normalized size = 0.98

$$\frac{2\sqrt{\sin(a+bx)}\sqrt{\csc(a+bx)}\text{EllipticF}\left(\frac{1}{4}(-2a - 2bx + \pi), 2\right)}{b}$$

Antiderivative was successfully verified.

[In] Integrate[Sqrt[Csc[a + b*x]], x]

[Out] (-2*Sqrt[Csc[a + b*x]]*EllipticF[(-2*a + Pi - 2*b*x)/4, 2]*Sqrt[Sin[a + b*x]])/b

Maple [A] time = 0.836, size = 69, normalized size = 1.7

$$\frac{1}{\cos(bx+a)b} \sqrt{\sin(bx+a)+1} \sqrt{-2\sin(bx+a)+2} \sqrt{-\sin(bx+a)} \text{EllipticF}\left(\sqrt{\sin(bx+a)+1}, \frac{\sqrt{2}}{2}\right) \frac{1}{\sqrt{\sin(bx+a)}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(csc(b*x+a)^(1/2), x)

[Out] (sin(b*x+a)+1)^(1/2)*(-2*sin(b*x+a)+2)^(1/2)*(-sin(b*x+a))^(1/2)*EllipticF((sin(b*x+a)+1)^(1/2), 1/2*2^(1/2))/cos(b*x+a)/sin(b*x+a)^(1/2)/b

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \sqrt{\csc(bx+a)} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(csc(b*x+a)^(1/2),x, algorithm="maxima")
```

```
[Out] integrate(sqrt(csc(b*x + a)), x)
```

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\sqrt{\csc(bx + a)}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(csc(b*x+a)^(1/2),x, algorithm="fricas")
```

```
[Out] integral(sqrt(csc(b*x + a)), x)
```

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \sqrt{\csc(a + bx)} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(csc(b*x+a)**(1/2),x)
```

```
[Out] Integral(sqrt(csc(a + b*x)), x)
```

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \sqrt{\csc(bx + a)} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(csc(b*x+a)^(1/2),x, algorithm="giac")
```

```
[Out] integrate(sqrt(csc(b*x + a)), x)
```

3.13 $\int \frac{1}{\sqrt{\csc(a+bx)}} dx$

Optimal. Leaf size=41

$$\frac{2\sqrt{\sin(a+bx)}\sqrt{\csc(a+bx)}E\left(\frac{1}{2}\left(a+bx-\frac{\pi}{2}\right)\middle|2\right)}{b}$$

[Out] (2*Sqrt[Csc[a + b*x]]*EllipticE[(a - Pi/2 + b*x)/2, 2]*Sqrt[Sin[a + b*x]])/b

Rubi [A] time = 0.016806, antiderivative size = 41, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.2$, Rules used = {3771, 2639}

$$\frac{2\sqrt{\sin(a+bx)}\sqrt{\csc(a+bx)}E\left(\frac{1}{2}\left(a+bx-\frac{\pi}{2}\right)\middle|2\right)}{b}$$

Antiderivative was successfully verified.

[In] Int[1/Sqrt[Csc[a + b*x]],x]

[Out] (2*Sqrt[Csc[a + b*x]]*EllipticE[(a - Pi/2 + b*x)/2, 2]*Sqrt[Sin[a + b*x]])/b

Rule 3771

Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] :> Dist[(b*Csc[c + d*x])^n*Sin[c + d*x]^n, Int[1/Sin[c + d*x]^n, x], x] /; FreeQ[{b, c, d}, x] && EqQ[n^2, 1/4]

Rule 2639

Int[Sqrt[sin[(c_.) + (d_.)*(x_)]], x_Symbol] :> Simp[(2*EllipticE[(1*(c - Pi/2 + d*x))/2, 2])/d, x] /; FreeQ[{c, d}, x]

Rubi steps

$$\int \frac{1}{\sqrt{\csc(a+bx)}} dx = (\sqrt{\csc(a+bx)}\sqrt{\sin(a+bx)}) \int \sqrt{\sin(a+bx)} dx$$

$$= \frac{2\sqrt{\csc(a+bx)}E\left(\frac{1}{2}\left(a - \frac{\pi}{2} + bx\right)\middle|2\right)\sqrt{\sin(a+bx)}}{b}$$

Mathematica [A] time = 0.0386796, size = 40, normalized size = 0.98

$$-\frac{2\sqrt{\sin(a+bx)}\sqrt{\csc(a+bx)}E\left(\frac{1}{4}(-2a-2bx+\pi)\middle|2\right)}{b}$$

Antiderivative was successfully verified.

[In] Integrate[1/Sqrt[Csc[a + b*x]],x]

[Out] (-2*Sqrt[Csc[a + b*x]]*EllipticE[(-2*a + Pi - 2*b*x)/4, 2]*Sqrt[Sin[a + b*x]])/b

Maple [A] time = 1.095, size = 91, normalized size = 2.2

$$-\frac{1}{\cos(bx+a)b}\sqrt{\sin(bx+a)+1}\sqrt{-2\sin(bx+a)+2}\sqrt{-\sin(bx+a)}\left(2\text{EllipticE}\left(\sqrt{\sin(bx+a)+1},1/2\sqrt{2}\right)-\text{EllipticF}\left(\sqrt{\sin(bx+a)+1},1/2\sqrt{2}\right)\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(1/csc(b*x+a)^(1/2),x)

[Out] -(sin(b*x+a)+1)^(1/2)*(-2*sin(b*x+a)+2)^(1/2)*(-sin(b*x+a))^(1/2)*(2*EllipticE((sin(b*x+a)+1)^(1/2),1/2*2^(1/2))-EllipticF((sin(b*x+a)+1)^(1/2),1/2*2^(1/2)))/cos(b*x+a)/sin(b*x+a)^(1/2)/b

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\sqrt{\csc(bx+a)}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/csc(b*x+a)^(1/2),x, algorithm="maxima")

[Out] integrate(1/sqrt(csc(b*x + a)), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\frac{1}{\sqrt{\csc(bx + a)}}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/csc(b*x+a)^(1/2),x, algorithm="fricas")

[Out] integral(1/sqrt(csc(b*x + a)), x)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\sqrt{\csc(a + bx)}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/csc(b*x+a)**(1/2),x)

[Out] Integral(1/sqrt(csc(a + b*x)), x)

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\sqrt{\csc(bx + a)}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/csc(b*x+a)^(1/2),x, algorithm="giac")

[Out] integrate(1/sqrt(csc(b*x + a)), x)

$$3.14 \quad \int \frac{1}{\csc^2(a+bx)} dx$$

Optimal. Leaf size=67

$$\frac{2\sqrt{\sin(a+bx)}\sqrt{\csc(a+bx)}\text{EllipticF}\left(\frac{1}{2}\left(a+bx-\frac{\pi}{2}\right), 2\right)}{3b} - \frac{2\cos(a+bx)}{3b\sqrt{\csc(a+bx)}}$$

[Out] $(-2*\text{Cos}[a + b*x])/(3*b*\text{Sqrt}[\text{Csc}[a + b*x]]) + (2*\text{Sqrt}[\text{Csc}[a + b*x]]*\text{EllipticF}[(a - \text{Pi}/2 + b*x)/2, 2]*\text{Sqrt}[\text{Sin}[a + b*x]])/(3*b)$

Rubi [A] time = 0.0269316, antiderivative size = 67, normalized size of antiderivative = 1., number of steps used = 3, number of rules used = 3, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.3$, Rules used = {3769, 3771, 2641}

$$\frac{2\sqrt{\sin(a+bx)}\sqrt{\csc(a+bx)}F\left(\frac{1}{2}\left(a+bx-\frac{\pi}{2}\right)\middle|2\right)}{3b} - \frac{2\cos(a+bx)}{3b\sqrt{\csc(a+bx)}}$$

Antiderivative was successfully verified.

[In] $\text{Int}[\text{Csc}[a + b*x]^{(-3/2)}, x]$

[Out] $(-2*\text{Cos}[a + b*x])/(3*b*\text{Sqrt}[\text{Csc}[a + b*x]]) + (2*\text{Sqrt}[\text{Csc}[a + b*x]]*\text{EllipticF}[(a - \text{Pi}/2 + b*x)/2, 2]*\text{Sqrt}[\text{Sin}[a + b*x]])/(3*b)$

Rule 3769

```
Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Simp[(Cos[c + d*x]*(
b*Csc[c + d*x])^(n + 1))/(b*d*n), x] + Dist[(n + 1)/(b^2*n), Int[(b*Csc[c +
d*x])^(n + 2), x], x] /; FreeQ[{b, c, d}, x] && LtQ[n, -1] && IntegerQ[2*n
]
```

Rule 3771

```
Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Dist[(b*Csc[c + d*x]
)^(n)*Sin[c + d*x]^n, Int[1/Sin[c + d*x]^n, x], x] /; FreeQ[{b, c, d}, x] &&
EqQ[n^2, 1/4]
```

Rule 2641

```
Int[1/Sqrt[sin[(c_.) + (d_.)*(x_)]], x_Symbol] := Simp[(2*EllipticF[(1*(c -
Pi/2 + d*x))/2, 2])/d, x] /; FreeQ[{c, d}, x]
```

Rubi steps

$$\begin{aligned} \int \frac{1}{\csc^3(a+bx)} dx &= -\frac{2 \cos(a+bx)}{3b\sqrt{\csc(a+bx)}} + \frac{1}{3} \int \sqrt{\csc(a+bx)} dx \\ &= -\frac{2 \cos(a+bx)}{3b\sqrt{\csc(a+bx)}} + \frac{1}{3} \left(\sqrt{\csc(a+bx)} \sqrt{\sin(a+bx)} \right) \int \frac{1}{\sqrt{\sin(a+bx)}} dx \\ &= -\frac{2 \cos(a+bx)}{3b\sqrt{\csc(a+bx)}} + \frac{2\sqrt{\csc(a+bx)} F\left(\frac{1}{2}\left(a - \frac{\pi}{2} + bx\right) \middle| 2\right) \sqrt{\sin(a+bx)}}{3b} \end{aligned}$$

Mathematica [A] time = 0.0573173, size = 53, normalized size = 0.79

$$\frac{\sqrt{\csc(a+bx)} \left(2\sqrt{\sin(a+bx)} \text{EllipticF}\left(\frac{1}{4}(-2a - 2bx + \pi), 2\right) + \sin(2(a+bx)) \right)}{3b}$$

Antiderivative was successfully verified.

```
[In] Integrate[Csc[a + b*x]^(-3/2), x]
```

```
[Out] -(Sqrt[Csc[a + b*x]]*(2*EllipticF[(-2*a + Pi - 2*b*x)/4, 2]*Sqrt[Sin[a + b*x]] + Sin[2*(a + b*x)]))/(3*b)
```

Maple [A] time = 1.323, size = 88, normalized size = 1.3

$$\frac{1}{\cos(bx+a)b} \left(\frac{1}{3} \sqrt{\sin(bx+a)+1} \sqrt{-2\sin(bx+a)+2} \sqrt{-\sin(bx+a)} \text{EllipticF}\left(\sqrt{\sin(bx+a)+1}, \frac{\sqrt{2}}{2}\right) - \frac{2(\cos(bx+a)+1)}{\sin(bx+a)} \right)$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] int(1/csc(b*x+a)^(3/2), x)
```

```
[Out] (1/3*(sin(b*x+a)+1)^(1/2)*(-2*sin(b*x+a)+2)^(1/2)*(-sin(b*x+a))^(1/2)*EllipticF((sin(b*x+a)+1)^(1/2), 1/2*2^(1/2))-2/3*cos(b*x+a)^2*sin(b*x+a))/cos(b*x+a)/sin(b*x+a)^(1/2)/b
```

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\csc(bx + a)^{\frac{3}{2}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/csc(b*x+a)^(3/2),x, algorithm="maxima")

[Out] integrate(csc(b*x + a)^(-3/2), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\frac{1}{\csc(bx + a)^{\frac{3}{2}}}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/csc(b*x+a)^(3/2),x, algorithm="fricas")

[Out] integral(csc(b*x + a)^(-3/2), x)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\csc^{\frac{3}{2}}(a + bx)} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/csc(b*x+a)**(3/2),x)

[Out] Integral(csc(a + b*x)**(-3/2), x)

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\csc(bx + a)^{\frac{3}{2}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/csc(b*x+a)^(3/2),x, algorithm="giac")
```

```
[Out] integrate(csc(b*x + a)^(-3/2), x)
```

$$3.15 \quad \int \frac{1}{5 \csc^2(a+bx)} dx$$

Optimal. Leaf size=67

$$\frac{6\sqrt{\sin(a+bx)}\sqrt{\csc(a+bx)}E\left(\frac{1}{2}\left(a+bx-\frac{\pi}{2}\right)\middle|2\right)}{5b} - \frac{2\cos(a+bx)}{5b \csc^{\frac{3}{2}}(a+bx)}$$

[Out] (-2*Cos[a + b*x])/(5*b*Csc[a + b*x]^(3/2)) + (6*Sqrt[Csc[a + b*x]]*EllipticE[(a - Pi/2 + b*x)/2, 2]*Sqrt[Sin[a + b*x]])/(5*b)

Rubi [A] time = 0.0258078, antiderivative size = 67, normalized size of antiderivative = 1., number of steps used = 3, number of rules used = 3, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.3$, Rules used = {3769, 3771, 2639}

$$\frac{6\sqrt{\sin(a+bx)}\sqrt{\csc(a+bx)}E\left(\frac{1}{2}\left(a+bx-\frac{\pi}{2}\right)\middle|2\right)}{5b} - \frac{2\cos(a+bx)}{5b \csc^{\frac{3}{2}}(a+bx)}$$

Antiderivative was successfully verified.

[In] Int[Csc[a + b*x]^(-5/2), x]

[Out] (-2*Cos[a + b*x])/(5*b*Csc[a + b*x]^(3/2)) + (6*Sqrt[Csc[a + b*x]]*EllipticE[(a - Pi/2 + b*x)/2, 2]*Sqrt[Sin[a + b*x]])/(5*b)

Rule 3769

```
Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Simp[(Cos[c + d*x]*(b*Csc[c + d*x])^(n + 1))/(b*d*n), x] + Dist[(n + 1)/(b^2*n), Int[(b*Csc[c + d*x])^(n + 2), x], x] /; FreeQ[{b, c, d}, x] && LtQ[n, -1] && IntegerQ[2*n]
```

Rule 3771

```
Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Dist[(b*Csc[c + d*x])^n*Sin[c + d*x]^n, Int[1/Sin[c + d*x]^n, x], x] /; FreeQ[{b, c, d}, x] && EqQ[n^2, 1/4]
```

Rule 2639

```
Int[Sqrt[sin[(c_.) + (d_.)*(x_.)], x_Symbol] :> Simp[(2*EllipticE[(1*(c - P
i/2 + d*x))/2, 2])/d, x] /; FreeQ[{c, d}, x]
```

Rubi steps

$$\begin{aligned} \int \frac{1}{\csc^2(a+bx)} dx &= -\frac{2 \cos(a+bx)}{5b \csc^{\frac{3}{2}}(a+bx)} + \frac{3}{5} \int \frac{1}{\sqrt{\csc(a+bx)}} dx \\ &= -\frac{2 \cos(a+bx)}{5b \csc^{\frac{3}{2}}(a+bx)} + \frac{1}{5} (3\sqrt{\csc(a+bx)}\sqrt{\sin(a+bx)}) \int \sqrt{\sin(a+bx)} dx \\ &= -\frac{2 \cos(a+bx)}{5b \csc^{\frac{3}{2}}(a+bx)} + \frac{6\sqrt{\csc(a+bx)}E\left(\frac{1}{2}\left(a - \frac{\pi}{2} + bx\right)\middle|2\right)\sqrt{\sin(a+bx)}}{5b} \end{aligned}$$

Mathematica [A] time = 0.106665, size = 60, normalized size = 0.9

$$\frac{2\sqrt{\csc(a+bx)}\left(\sin^2(a+bx)\cos(a+bx) + 3\sqrt{\sin(a+bx)}E\left(\frac{1}{4}(-2a-2bx+\pi)\middle|2\right)\right)}{5b}$$

Antiderivative was successfully verified.

```
[In] Integrate[Csc[a + b*x]^(-5/2), x]
```

```
[Out] (-2*Sqrt[Csc[a + b*x]]*(3*EllipticE[(-2*a + Pi - 2*b*x)/4, 2]*Sqrt[Sin[a +
b*x]] + Cos[a + b*x]*Sin[a + b*x]^2))/(5*b)
```

Maple [A] time = 1.229, size = 142, normalized size = 2.1

$$\frac{1}{\cos(bx+a)b} \left(\frac{2(\sin(bx+a))^4}{5} - \frac{2(\sin(bx+a))^2}{5} - \frac{6}{5} \sqrt{\sin(bx+a)+1} \sqrt{-2\sin(bx+a)+2} \sqrt{-\sin(bx+a)} \text{EllipticE} \right)$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] int(1/csc(b*x+a)^(5/2), x)
```

```
[Out] (2/5*sin(b*x+a)^4-2/5*sin(b*x+a)^2-6/5*(sin(b*x+a)+1)^(1/2)*(-2*sin(b*x+a)+
2)^(1/2)*(-sin(b*x+a))^(1/2)*EllipticE((sin(b*x+a)+1)^(1/2),1/2*2^(1/2))+3/
5*(sin(b*x+a)+1)^(1/2)*(-2*sin(b*x+a)+2)^(1/2)*(-sin(b*x+a))^(1/2)*Elliptic
```

$F((\sin(b*x+a)+1)^{(1/2)}, 1/2*2^{(1/2)})/\cos(b*x+a)/\sin(b*x+a)^{(1/2)}/b$

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\csc(bx + a)^{\frac{5}{2}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/csc(b*x+a)^(5/2),x, algorithm="maxima")

[Out] integrate(csc(b*x + a)^(-5/2), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\frac{1}{\csc(bx + a)^{\frac{5}{2}}}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/csc(b*x+a)^(5/2),x, algorithm="fricas")

[Out] integral(csc(b*x + a)^(-5/2), x)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\csc^{\frac{5}{2}}(a + bx)} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/csc(b*x+a)**(5/2),x)

[Out] Integral(csc(a + b*x)**(-5/2), x)

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\csc(bx + a)^{\frac{5}{2}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/csc(b*x+a)^(5/2),x, algorithm="giac")
```

```
[Out] integrate(csc(b*x + a)^(-5/2), x)
```

$$3.16 \quad \int \frac{1}{7 \csc^2(a+bx)} dx$$

Optimal. Leaf size=90

$$\frac{10\sqrt{\sin(a+bx)}\sqrt{\csc(a+bx)}\text{EllipticF}\left(\frac{1}{2}\left(a+bx-\frac{\pi}{2}\right), 2\right)}{21b} - \frac{2\cos(a+bx)}{7b \csc^{\frac{5}{2}}(a+bx)} - \frac{10\cos(a+bx)}{21b\sqrt{\csc(a+bx)}}$$

[Out] $(-2*\text{Cos}[a + b*x])/(7*b*\text{Csc}[a + b*x]^{(5/2)}) - (10*\text{Cos}[a + b*x])/(21*b*\text{Sqrt}[\text{Csc}[a + b*x]]) + (10*\text{Sqrt}[\text{Csc}[a + b*x]]*\text{EllipticF}[(a - \text{Pi}/2 + b*x)/2, 2]*\text{Sqrt}[\text{Sin}[a + b*x]])/(21*b)$

Rubi [A] time = 0.0383128, antiderivative size = 90, normalized size of antiderivative = 1., number of steps used = 4, number of rules used = 3, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.3$, Rules used = {3769, 3771, 2641}

$$-\frac{2\cos(a+bx)}{7b \csc^{\frac{5}{2}}(a+bx)} - \frac{10\cos(a+bx)}{21b\sqrt{\csc(a+bx)}} + \frac{10\sqrt{\sin(a+bx)}\sqrt{\csc(a+bx)}F\left(\frac{1}{2}\left(a+bx-\frac{\pi}{2}\right)\middle|2\right)}{21b}$$

Antiderivative was successfully verified.

[In] $\text{Int}[\text{Csc}[a + b*x]^{(-7/2)}, x]$

[Out] $(-2*\text{Cos}[a + b*x])/(7*b*\text{Csc}[a + b*x]^{(5/2)}) - (10*\text{Cos}[a + b*x])/(21*b*\text{Sqrt}[\text{Csc}[a + b*x]]) + (10*\text{Sqrt}[\text{Csc}[a + b*x]]*\text{EllipticF}[(a - \text{Pi}/2 + b*x)/2, 2]*\text{Sqrt}[\text{Sin}[a + b*x]])/(21*b)$

Rule 3769

```
Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Simp[(Cos[c + d*x]*(b*Csc[c + d*x])^(n + 1))/(b*d*n), x] + Dist[(n + 1)/(b^2*n), Int[(b*Csc[c + d*x])^(n + 2), x], x] /; FreeQ[{b, c, d}, x] && LtQ[n, -1] && IntegerQ[2*n]
```

Rule 3771

```
Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Dist[(b*Csc[c + d*x])^n*Sin[c + d*x]^n, Int[1/Sin[c + d*x]^n, x], x] /; FreeQ[{b, c, d}, x] && EqQ[n^2, 1/4]
```

Rule 2641

```
Int[1/Sqrt[sin[(c_.) + (d_.)*(x_)]], x_Symbol] := Simp[(2*EllipticF[(1*(c -
  Pi/2 + d*x))/2, 2])/d, x] /; FreeQ[{c, d}, x]
```

Rubi steps

$$\begin{aligned}
 \int \frac{1}{\csc^{\frac{7}{2}}(a+bx)} dx &= -\frac{2 \cos(a+bx)}{7b \csc^{\frac{5}{2}}(a+bx)} + \frac{5}{7} \int \frac{1}{\csc^{\frac{3}{2}}(a+bx)} dx \\
 &= -\frac{2 \cos(a+bx)}{7b \csc^{\frac{5}{2}}(a+bx)} - \frac{10 \cos(a+bx)}{21b \sqrt{\csc(a+bx)}} + \frac{5}{21} \int \sqrt{\csc(a+bx)} dx \\
 &= -\frac{2 \cos(a+bx)}{7b \csc^{\frac{5}{2}}(a+bx)} - \frac{10 \cos(a+bx)}{21b \sqrt{\csc(a+bx)}} + \frac{1}{21} \left(5 \sqrt{\csc(a+bx)} \sqrt{\sin(a+bx)} \right) \int \frac{1}{\sqrt{\sin(a+bx)}} dx \\
 &= -\frac{2 \cos(a+bx)}{7b \csc^{\frac{5}{2}}(a+bx)} - \frac{10 \cos(a+bx)}{21b \sqrt{\csc(a+bx)}} + \frac{10 \sqrt{\csc(a+bx)} F\left(\frac{1}{2}\left(a - \frac{\pi}{2} + bx\right) \middle| 2\right) \sqrt{\sin(a+bx)}}{21b}
 \end{aligned}$$

Mathematica [A] time = 0.165642, size = 65, normalized size = 0.72

$$\frac{\sqrt{\csc(a+bx)} \left(40 \sqrt{\sin(a+bx)} \text{EllipticF}\left(\frac{1}{4}(-2a - 2bx + \pi), 2\right) + 26 \sin(2(a+bx)) - 3 \sin(4(a+bx)) \right)}{84b}$$

Antiderivative was successfully verified.

```
[In] Integrate[Csc[a + b*x]^(-7/2), x]
```

```
[Out] -(Sqrt[Csc[a + b*x]]*(40*EllipticF[(-2*a + Pi - 2*b*x)/4, 2]*Sqrt[Sin[a + b
*x]] + 26*Sin[2*(a + b*x)] - 3*Sin[4*(a + b*x)]))/(84*b)
```

Maple [A] time = 1.198, size = 104, normalized size = 1.2

$$\frac{1}{\cos(bx+a)b} \left(\frac{2 \sin(bx+a) (\cos(bx+a))^4}{7} + \frac{5}{21} \sqrt{\sin(bx+a)+1} \sqrt{-2 \sin(bx+a)+2} \sqrt{-\sin(bx+a)} \text{EllipticF}\left(\sqrt{\sin(bx+a)+1}, \frac{1}{2}\right) \right)$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] int(1/csc(b*x+a)^(7/2), x)
```


[Out] $(2/7*\sin(b*x+a)*\cos(b*x+a)^4+5/21*(\sin(b*x+a)+1)^{(1/2)}*(-2*\sin(b*x+a)+2)^{(1/2)}*(-\sin(b*x+a))^{(1/2)}*\text{EllipticF}((\sin(b*x+a)+1)^{(1/2)},1/2*2^{(1/2)})-16/21*\cos(b*x+a)^2*\sin(b*x+a))/\cos(b*x+a)/\sin(b*x+a)^{(1/2)}/b$

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\csc(bx+a)^{7/2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/csc(b*x+a)^(7/2),x, algorithm="maxima")`

[Out] `integrate(csc(b*x + a)^(-7/2), x)`

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\frac{1}{\csc(bx+a)^{7/2}}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/csc(b*x+a)^(7/2),x, algorithm="fricas")`

[Out] `integral(csc(b*x + a)^(-7/2), x)`

Sympy [F(-1)] time = 0., size = 0, normalized size = 0.

Timed out

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/csc(b*x+a)**(7/2),x)`

[Out] Timed out

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\csc(bx + a)^{\frac{7}{2}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/csc(b*x+a)^(7/2),x, algorithm="giac")

[Out] integrate(csc(b*x + a)^(-7/2), x)

3.17 $\int (c \csc(a + bx))^{7/2} dx$

Optimal. Leaf size=103

$$-\frac{6c^3 \cos(a + bx) \sqrt{c \csc(a + bx)}}{5b} - \frac{6c^4 E\left(\frac{1}{2}\left(a + bx - \frac{\pi}{2}\right) \middle| 2\right)}{5b \sqrt{\sin(a + bx)} \sqrt{c \csc(a + bx)}} - \frac{2c \cos(a + bx) (c \csc(a + bx))^{5/2}}{5b}$$

[Out] $(-6*c^3*\text{Cos}[a + b*x]*\text{Sqrt}[c*\text{Csc}[a + b*x]])/(5*b) - (2*c*\text{Cos}[a + b*x]*(c*\text{Csc}[a + b*x])^{(5/2)})/(5*b) - (6*c^4*\text{EllipticE}[(a - \text{Pi}/2 + b*x)/2, 2])/(5*b*\text{Sqrt}[c*\text{Csc}[a + b*x]]*\text{Sqrt}[\text{Sin}[a + b*x]])$

Rubi [A] time = 0.0528121, antiderivative size = 103, normalized size of antiderivative = 1., number of steps used = 4, number of rules used = 3, integrand size = 12, $\frac{\text{number of rules}}{\text{integrand size}} = 0.25$, Rules used = {3768, 3771, 2639}

$$-\frac{6c^3 \cos(a + bx) \sqrt{c \csc(a + bx)}}{5b} - \frac{6c^4 E\left(\frac{1}{2}\left(a + bx - \frac{\pi}{2}\right) \middle| 2\right)}{5b \sqrt{\sin(a + bx)} \sqrt{c \csc(a + bx)}} - \frac{2c \cos(a + bx) (c \csc(a + bx))^{5/2}}{5b}$$

Antiderivative was successfully verified.

[In] $\text{Int}[(c*\text{Csc}[a + b*x])^{(7/2)}, x]$

[Out] $(-6*c^3*\text{Cos}[a + b*x]*\text{Sqrt}[c*\text{Csc}[a + b*x]])/(5*b) - (2*c*\text{Cos}[a + b*x]*(c*\text{Csc}[a + b*x])^{(5/2)})/(5*b) - (6*c^4*\text{EllipticE}[(a - \text{Pi}/2 + b*x)/2, 2])/(5*b*\text{Sqrt}[c*\text{Csc}[a + b*x]]*\text{Sqrt}[\text{Sin}[a + b*x]])$

Rule 3768

$\text{Int}[(\text{csc}[(c_.) + (d_.)*(x_.)]*(b_.))^{(n_.)}, x_Symbol] \rightarrow -\text{Simp}[(b*\text{Cos}[c + d*x])*(b*\text{Csc}[c + d*x])^{(n - 1)})/(d*(n - 1)), x] + \text{Dist}[(b^2*(n - 2))/(n - 1), \text{Int}[(b*\text{Csc}[c + d*x])^{(n - 2)}, x], x] /;$ FreeQ[{b, c, d}, x] && GtQ[n, 1] && IntegerQ[2*n]

Rule 3771

$\text{Int}[(\text{csc}[(c_.) + (d_.)*(x_.)]*(b_.))^{(n_.)}, x_Symbol] \rightarrow \text{Dist}[(b*\text{Csc}[c + d*x])^{(n)}*\text{Sin}[c + d*x]^n, \text{Int}[1/\text{Sin}[c + d*x]^n, x], x] /;$ FreeQ[{b, c, d}, x] && EqQ[n^2, 1/4]

Rule 2639

```
Int[Sqrt[sin[(c_.) + (d_.)*(x_)]], x_Symbol] := Simp[(2*EllipticE[(1*(c - P
i/2 + d*x))/2, 2])/d, x] /; FreeQ[{c, d}, x]
```

Rubi steps

$$\begin{aligned} \int (c \csc(a + bx))^{7/2} dx &= -\frac{2c \cos(a + bx)(c \csc(a + bx))^{5/2}}{5b} + \frac{1}{5} (3c^2) \int (c \csc(a + bx))^{3/2} dx \\ &= -\frac{6c^3 \cos(a + bx) \sqrt{c \csc(a + bx)}}{5b} - \frac{2c \cos(a + bx)(c \csc(a + bx))^{5/2}}{5b} - \frac{1}{5} (3c^4) \int \frac{1}{\sqrt{c \csc(a + bx)}} dx \\ &= -\frac{6c^3 \cos(a + bx) \sqrt{c \csc(a + bx)}}{5b} - \frac{2c \cos(a + bx)(c \csc(a + bx))^{5/2}}{5b} - \frac{(3c^4) \int \sqrt{\sin(a + bx)} dx}{5\sqrt{c \csc(a + bx)} \sqrt{\sin(a + bx)}} \\ &= -\frac{6c^3 \cos(a + bx) \sqrt{c \csc(a + bx)}}{5b} - \frac{2c \cos(a + bx)(c \csc(a + bx))^{5/2}}{5b} - \frac{6c^4 E\left(\frac{1}{2}\left(a - \frac{\pi}{2} + bx\right) \middle| 2\right)}{5b\sqrt{c \csc(a + bx)} \sqrt{\sin(a + bx)}} \end{aligned}$$

Mathematica [A] time = 0.196421, size = 67, normalized size = 0.65

$$\frac{(c \csc(a + bx))^{7/2} \left(-10 \sin(2(a + bx)) + 3 \sin(4(a + bx)) + 24 \sin^2(a + bx) E\left(\frac{1}{4}(-2a - 2bx + \pi) \middle| 2\right) \right)}{20b}$$

Antiderivative was successfully verified.

```
[In] Integrate[(c*Csc[a + b*x])^(7/2), x]
```

```
[Out] ((c*Csc[a + b*x])^(7/2)*(24*EllipticE[(-2*a + Pi - 2*b*x)/4, 2]*Sin[a + b*x]
)^(7/2) - 10*Sin[2*(a + b*x)] + 3*Sin[4*(a + b*x)])/(20*b)
```

Maple [C] time = 0.335, size = 1029, normalized size = 10.

result too large to display

Verification of antiderivative is not currently implemented for this CAS.

```
[In] int((c*csc(b*x+a))^(7/2), x)
```

```
[Out] 1/5/b*2^(1/2)*(3*cos(b*x+a)^3*(-I*(-1+cos(b*x+a))/sin(b*x+a))^(1/2)*Ellipti
cF(((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2), 1/2*2^(1/2))*((-I*cos(b*x
```

```

+a)+sin(b*x+a)+I)/sin(b*x+a))^(1/2)*((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a)
)^(1/2)-6*cos(b*x+a)^3*(-I*(-1+cos(b*x+a))/sin(b*x+a))^(1/2)*((-I*cos(b*x+a)
)+sin(b*x+a)+I)/sin(b*x+a))^(1/2)*((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(
1/2)*EllipticE(((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2),1/2*2^(1/2))
+3*EllipticF(((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2),1/2*2^(1/2))*(-
I*(-1+cos(b*x+a))/sin(b*x+a))^(1/2)*cos(b*x+a)^2*((-I*cos(b*x+a)+sin(b*x+a)
+I)/sin(b*x+a))^(1/2)*((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2)-6*(-I*
(-1+cos(b*x+a))/sin(b*x+a))^(1/2)*cos(b*x+a)^2*EllipticE(((I*cos(b*x+a)+sin
(b*x+a)-I)/sin(b*x+a))^(1/2),1/2*2^(1/2))*((-I*cos(b*x+a)+sin(b*x+a)+I)/sin
(b*x+a))^(1/2)*((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2)-3*EllipticF((
(I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2),1/2*2^(1/2))*(-I*(-1+cos(b*x+
a))/sin(b*x+a))^(1/2)*cos(b*x+a)*((-I*cos(b*x+a)+sin(b*x+a)+I)/sin(b*x+a))^(
1/2)*((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2)+6*(-I*(-1+cos(b*x+a))/
sin(b*x+a))^(1/2)*cos(b*x+a)*EllipticE(((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x
+a))^(1/2),1/2*2^(1/2))*((-I*cos(b*x+a)+sin(b*x+a)+I)/sin(b*x+a))^(1/2)*((I
*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2)-3*EllipticF(((I*cos(b*x+a)+sin(
b*x+a)-I)/sin(b*x+a))^(1/2),1/2*2^(1/2))*(-I*(-1+cos(b*x+a))/sin(b*x+a))^(1
/2)*((-I*cos(b*x+a)+sin(b*x+a)+I)/sin(b*x+a))^(1/2)*((I*cos(b*x+a)+sin(b*x+
a)-I)/sin(b*x+a))^(1/2)+6*(-I*(-1+cos(b*x+a))/sin(b*x+a))^(1/2)*EllipticE((
(I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2),1/2*2^(1/2))*((-I*cos(b*x+a)+
sin(b*x+a)+I)/sin(b*x+a))^(1/2)*((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1
/2)+3*2^(1/2)*cos(b*x+a)^2-2^(1/2)*cos(b*x+a)-3*2^(1/2))*sin(b*x+a)*(c/sin(
b*x+a))^(7/2)

```

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int (c \csc(bx + a))^{7/2} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((c*csc(b*x+a))^(7/2),x, algorithm="maxima")

[Out] integrate((c*csc(b*x + a))^(7/2), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\sqrt{c \csc(bx + a)} c^3 \csc(bx + a)^3, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate((c*csc(b*x+a))^(7/2),x, algorithm="fricas")
```

```
[Out] integral(sqrt(c*csc(b*x + a))*c^3*csc(b*x + a)^3, x)
```

Sympy [F(-1)] time = 0., size = 0, normalized size = 0.

Timed out

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate((c*csc(b*x+a))**(7/2),x)
```

```
[Out] Timed out
```

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int (c \csc (bx + a))^{\frac{7}{2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate((c*csc(b*x+a))^(7/2),x, algorithm="giac")
```

```
[Out] integrate((c*csc(b*x + a))^(7/2), x)
```

3.18 $\int (c \csc(a + bx))^{5/2} dx$

Optimal. Leaf size=75

$$\frac{2c^2 \sqrt{\sin(a + bx)} \operatorname{EllipticF}\left(\frac{1}{2}\left(a + bx - \frac{\pi}{2}\right), 2\right) \sqrt{c \csc(a + bx)}}{3b} - \frac{2c \cos(a + bx)(c \csc(a + bx))^{3/2}}{3b}$$

[Out] $(-2*c*\cos[a + b*x]*(c*\csc[a + b*x])^{(3/2)})/(3*b) + (2*c^2*\sqrt{c*\csc[a + b*x]})*\operatorname{EllipticF}[(a - \pi/2 + b*x)/2, 2]*\sqrt{\sin[a + b*x]}/(3*b)$

Rubi [A] time = 0.0310997, antiderivative size = 75, normalized size of antiderivative = 1., number of steps used = 3, number of rules used = 3, integrand size = 12, $\frac{\text{number of rules}}{\text{integrand size}} = 0.25$, Rules used = {3768, 3771, 2641}

$$\frac{2c^2 \sqrt{\sin(a + bx)} F\left(\frac{1}{2}\left(a + bx - \frac{\pi}{2}\right) \middle| 2\right) \sqrt{c \csc(a + bx)}}{3b} - \frac{2c \cos(a + bx)(c \csc(a + bx))^{3/2}}{3b}$$

Antiderivative was successfully verified.

[In] $\operatorname{Int}[(c*\csc[a + b*x])^{(5/2)}, x]$

[Out] $(-2*c*\cos[a + b*x]*(c*\csc[a + b*x])^{(3/2)})/(3*b) + (2*c^2*\sqrt{c*\csc[a + b*x]})*\operatorname{EllipticF}[(a - \pi/2 + b*x)/2, 2]*\sqrt{\sin[a + b*x]}/(3*b)$

Rule 3768

$\operatorname{Int}[(\csc[(c_.) + (d_.)*(x_.)]*(b_.))^{(n_.)}, x_Symbol] := -\operatorname{Simp}[(b*\cos[c + d*x])*(b*\csc[c + d*x])^{(n - 1)} / (d*(n - 1)), x] + \operatorname{Dist}[(b^2*(n - 2)) / (n - 1), \operatorname{Int}[(b*\csc[c + d*x])^{(n - 2)}, x], x] /;$ FreeQ[{b, c, d}, x] && GtQ[n, 1] && IntegerQ[2*n]

Rule 3771

$\operatorname{Int}[(\csc[(c_.) + (d_.)*(x_.)]*(b_.))^{(n_.)}, x_Symbol] := \operatorname{Dist}[(b*\csc[c + d*x])^{(n)} * \sin[c + d*x]^n, \operatorname{Int}[1/\sin[c + d*x]^n, x], x] /;$ FreeQ[{b, c, d}, x] && EqQ[n^2, 1/4]

Rule 2641

$\operatorname{Int}[1/\sqrt{\sin[(c_.) + (d_.)*(x_.)]}, x_Symbol] := \operatorname{Simp}[(2*\operatorname{EllipticF}[(1*(c - \pi/2 + d*x))/2, 2])/d, x] /;$ FreeQ[{c, d}, x]

Rubi steps

$$\begin{aligned}
\int (c \csc(a + bx))^{5/2} dx &= -\frac{2c \cos(a + bx)(c \csc(a + bx))^{3/2}}{3b} + \frac{1}{3}c^2 \int \sqrt{c \csc(a + bx)} dx \\
&= -\frac{2c \cos(a + bx)(c \csc(a + bx))^{3/2}}{3b} + \frac{1}{3} \left(c^2 \sqrt{c \csc(a + bx)} \sqrt{\sin(a + bx)} \right) \int \frac{1}{\sqrt{\sin(a + bx)}} dx \\
&= -\frac{2c \cos(a + bx)(c \csc(a + bx))^{3/2}}{3b} + \frac{2c^2 \sqrt{c \csc(a + bx)} F\left(\frac{1}{2}\left(a - \frac{\pi}{2} + bx\right) \middle| 2\right) \sqrt{\sin(a + bx)}}{3b}
\end{aligned}$$

Mathematica [A] time = 0.187472, size = 55, normalized size = 0.73

$$-\frac{(c \csc(a + bx))^{5/2} \left(2 \sin^{\frac{5}{2}}(a + bx) \text{EllipticF}\left(\frac{1}{4}(-2a - 2bx + \pi), 2\right) + \sin(2(a + bx)) \right)}{3b}$$

Antiderivative was successfully verified.

[In] Integrate[(c*Csc[a + b*x])^(5/2), x]

[Out] -((c*Csc[a + b*x])^(5/2)*(2*EllipticF[(-2*a + Pi - 2*b*x)/4, 2]*Sin[a + b*x]^(5/2) + Sin[2*(a + b*x)]))/(3*b)

Maple [C] time = 0.241, size = 319, normalized size = 4.3

$$\frac{\sqrt{2}(-1 + \cos(bx + a))^2 (\cos(bx + a) + 1)^2}{3b (\sin(bx + a))^3} \left(i \cos(bx + a) \sqrt{\frac{i \cos(bx + a) + \sin(bx + a) - i}{\sin(bx + a)}} \sqrt{\frac{-i(-1 + \cos(bx + a))}{\sin(bx + a)}} \sqrt{\frac{-i}{\sin(bx + a)}} \right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int((c*csc(b*x+a))^(5/2), x)

[Out] 1/3/b*2^(1/2)*(-1+cos(b*x+a))^2*(I*cos(b*x+a)*((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2)*(-I*(-1+cos(b*x+a))/sin(b*x+a))^(1/2)*(-(I*cos(b*x+a)-sin(b*x+a)-I)/sin(b*x+a))^(1/2)*sin(b*x+a)*EllipticF(((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2), 1/2*2^(1/2))+I*((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2)*(-I*(-1+cos(b*x+a))/sin(b*x+a))^(1/2)*(-(I*cos(b*x+a)-sin(b*x+a)-I)/sin(b*x+a))^(1/2)*sin(b*x+a)*EllipticF(((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2), 1/2*2^(1/2))-2^(1/2)*cos(b*x+a)*(cos(b*x+a)+1)^2*(c/sin(b*x+a))

))^(5/2)/sin(b*x+a)^3

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int (c \csc (bx + a))^{\frac{5}{2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((c*csc(b*x+a))^(5/2),x, algorithm="maxima")

[Out] integrate((c*csc(b*x + a))^(5/2), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\sqrt{c \csc (bx + a)} c^2 \csc (bx + a)^2, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((c*csc(b*x+a))^(5/2),x, algorithm="fricas")

[Out] integral(sqrt(c*csc(b*x + a))*c^2*csc(b*x + a)^2, x)

Sympy [F(-1)] time = 0., size = 0, normalized size = 0.

Timed out

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((c*csc(b*x+a))**(5/2),x)

[Out] Timed out

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int (c \csc (bx + a))^{\frac{5}{2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate((c*csc(b*x+a))^(5/2),x, algorithm="giac")
```

```
[Out] integrate((c*csc(b*x + a))^(5/2), x)
```

3.19 $\int (c \csc(a + bx))^{3/2} dx$

Optimal. Leaf size=71

$$-\frac{2c^2 E\left(\frac{1}{2}\left(a + bx - \frac{\pi}{2}\right)\middle| 2\right)}{b\sqrt{\sin(a + bx)}\sqrt{c \csc(a + bx)}} - \frac{2c \cos(a + bx)\sqrt{c \csc(a + bx)}}{b}$$

[Out] $(-2*c*\text{Cos}[a + b*x]*\text{Sqrt}[c*\text{Csc}[a + b*x]])/b - (2*c^2*\text{EllipticE}[(a - \text{Pi}/2 + b*x)/2, 2])/(b*\text{Sqrt}[c*\text{Csc}[a + b*x]]*\text{Sqrt}[\text{Sin}[a + b*x]])$

Rubi [A] time = 0.0319975, antiderivative size = 71, normalized size of antiderivative = 1., number of steps used = 3, number of rules used = 3, integrand size = 12, $\frac{\text{number of rules}}{\text{integrand size}} = 0.25$, Rules used = {3768, 3771, 2639}

$$-\frac{2c^2 E\left(\frac{1}{2}\left(a + bx - \frac{\pi}{2}\right)\middle| 2\right)}{b\sqrt{\sin(a + bx)}\sqrt{c \csc(a + bx)}} - \frac{2c \cos(a + bx)\sqrt{c \csc(a + bx)}}{b}$$

Antiderivative was successfully verified.

[In] $\text{Int}[(c*\text{Csc}[a + b*x])^{3/2}, x]$

[Out] $(-2*c*\text{Cos}[a + b*x]*\text{Sqrt}[c*\text{Csc}[a + b*x]])/b - (2*c^2*\text{EllipticE}[(a - \text{Pi}/2 + b*x)/2, 2])/(b*\text{Sqrt}[c*\text{Csc}[a + b*x]]*\text{Sqrt}[\text{Sin}[a + b*x]])$

Rule 3768

$\text{Int}[(\text{csc}[(c_.) + (d_.)*(x_.)]*(b_.))^{(n_.)}, x_Symbol] \text{ :> } -\text{Simp}[(b*\text{Cos}[c + d*x])*(b*\text{Csc}[c + d*x])^{(n - 1)}]/(d*(n - 1)), x] + \text{Dist}[(b^2*(n - 2))/(n - 1), \text{Int}[(b*\text{Csc}[c + d*x])^{(n - 2)}, x], x] \text{ /; FreeQ}\{b, c, d, x\} \ \&\& \ \text{GtQ}[n, 1] \ \&\& \ \text{IntegerQ}[2*n]$

Rule 3771

$\text{Int}[(\text{csc}[(c_.) + (d_.)*(x_.)]*(b_.))^{(n_.)}, x_Symbol] \text{ :> } \text{Dist}[(b*\text{Csc}[c + d*x])^n*\text{Sin}[c + d*x]^n, \text{Int}[1/\text{Sin}[c + d*x]^n, x], x] \text{ /; FreeQ}\{b, c, d, x\} \ \&\& \ \text{EqQ}[n^2, 1/4]$

Rule 2639

```
Int[Sqrt[sin[(c_.) + (d_.)*(x_.)], x_Symbol] := Simp[(2*EllipticE[(1*(c - P
i/2 + d*x))/2, 2])/d, x] /; FreeQ[{c, d}, x]
```

Rubi steps

$$\begin{aligned} \int (c \csc(a + bx))^{3/2} dx &= -\frac{2c \cos(a + bx) \sqrt{c \csc(a + bx)}}{b} - c^2 \int \frac{1}{\sqrt{c \csc(a + bx)}} dx \\ &= -\frac{2c \cos(a + bx) \sqrt{c \csc(a + bx)}}{b} - \frac{c^2 \int \sqrt{\sin(a + bx)} dx}{\sqrt{c \csc(a + bx)} \sqrt{\sin(a + bx)}} \\ &= -\frac{2c \cos(a + bx) \sqrt{c \csc(a + bx)}}{b} - \frac{2c^2 E\left(\frac{1}{2}\left(a - \frac{\pi}{2} + bx\right) \middle| 2\right)}{b \sqrt{c \csc(a + bx)} \sqrt{\sin(a + bx)}} \end{aligned}$$

Mathematica [A] time = 0.126562, size = 54, normalized size = 0.76

$$\frac{(c \csc(a + bx))^{3/2} \left(2 \sin^{\frac{3}{2}}(a + bx) E\left(\frac{1}{4}(-2a - 2bx + \pi) \middle| 2\right) - \sin(2(a + bx)) \right)}{b}$$

Antiderivative was successfully verified.

```
[In] Integrate[(c*Csc[a + b*x])^(3/2), x]
```

```
[Out] ((c*Csc[a + b*x])^(3/2)*(2*EllipticE[(-2*a + Pi - 2*b*x)/4, 2]*Sin[a + b*x]
^(3/2) - Sin[2*(a + b*x)]))/b
```

Maple [C] time = 0.219, size = 520, normalized size = 7.3

$$\frac{\sqrt{2} \sin(bx + a)}{b} \left(2 \sqrt{\frac{i \cos(bx + a) + \sin(bx + a) - i}{\sin(bx + a)}} \sqrt{-\frac{i \cos(bx + a) - \sin(bx + a) - i}{\sin(bx + a)}} \text{EllipticE} \left(\sqrt{\frac{i \cos(bx + a) + \sin(bx + a)}{\sin(bx + a)}} \right) \right)$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] int((c*csc(b*x+a))^(3/2), x)
```

```
[Out] 1/b*2^(1/2)*(2*((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2)*(-(I*cos(b*x+
a)-sin(b*x+a)-I)/sin(b*x+a))^(1/2)*EllipticE(((I*cos(b*x+a)+sin(b*x+a)-I)/s
in(b*x+a))^(1/2), 1/2*2^(1/2))*(-I*(-1+cos(b*x+a))/sin(b*x+a))^(1/2)*cos(b*x
```

+a)-((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2)*(-(I*cos(b*x+a)-sin(b*x+a)-I)/sin(b*x+a))^(1/2)*EllipticF(((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2),1/2*2^(1/2))*(-I*(-1+cos(b*x+a))/sin(b*x+a))^(1/2)*cos(b*x+a)+2*(-I*(-1+cos(b*x+a))/sin(b*x+a))^(1/2)*((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2)*(-(I*cos(b*x+a)-sin(b*x+a)-I)/sin(b*x+a))^(1/2)*EllipticE(((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2),1/2*2^(1/2))-(-I*(-1+cos(b*x+a))/sin(b*x+a))^(1/2)*((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2)*(-(I*cos(b*x+a)-sin(b*x+a)-I)/sin(b*x+a))^(1/2)*EllipticF(((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2),1/2*2^(1/2))-2^(1/2))*(c/sin(b*x+a))^(3/2)*sin(b*x+a)

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int (c \csc (bx + a))^{\frac{3}{2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((c*csc(b*x+a))^(3/2),x, algorithm="maxima")

[Out] integrate((c*csc(b*x + a))^(3/2), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}(\sqrt{c \csc (bx + a)} c \csc (bx + a), x)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((c*csc(b*x+a))^(3/2),x, algorithm="fricas")

[Out] integral(sqrt(c*csc(b*x + a))*c*csc(b*x + a), x)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int (c \csc (a + bx))^{\frac{3}{2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate((c*csc(b*x+a))**(3/2),x)
```

```
[Out] Integral((c*csc(a + b*x))**(3/2), x)
```

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int (c \csc(bx + a))^{\frac{3}{2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate((c*csc(b*x+a))^(3/2),x, algorithm="giac")
```

```
[Out] integrate((c*csc(b*x + a))^(3/2), x)
```

3.20 $\int \sqrt{c \csc(a + bx)} dx$

Optimal. Leaf size=43

$$\frac{2\sqrt{\sin(a + bx)}\text{EllipticF}\left(\frac{1}{2}\left(a + bx - \frac{\pi}{2}\right), 2\right)\sqrt{c \csc(a + bx)}}{b}$$

[Out] (2*Sqrt[c*Csc[a + b*x]]*EllipticF[(a - Pi/2 + b*x)/2, 2]*Sqrt[Sin[a + b*x]])/b

Rubi [A] time = 0.0181133, antiderivative size = 43, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 12, $\frac{\text{number of rules}}{\text{integrand size}} = 0.167$, Rules used = {3771, 2641}

$$\frac{2\sqrt{\sin(a + bx)}F\left(\frac{1}{2}\left(a + bx - \frac{\pi}{2}\right)\middle|2\right)\sqrt{c \csc(a + bx)}}{b}$$

Antiderivative was successfully verified.

[In] Int[Sqrt[c*Csc[a + b*x]],x]

[Out] (2*Sqrt[c*Csc[a + b*x]]*EllipticF[(a - Pi/2 + b*x)/2, 2]*Sqrt[Sin[a + b*x]])/b

Rule 3771

Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] :> Dist[(b*Csc[c + d*x])^n*Sin[c + d*x]^n, Int[1/Sin[c + d*x]^n, x], x] /; FreeQ[{b, c, d}, x] && EqQ[n^2, 1/4]

Rule 2641

Int[1/Sqrt[sin[(c_.) + (d_.)*(x_)]], x_Symbol] :> Simp[(2*EllipticF[(1*(c - Pi/2 + d*x))/2, 2])/d, x] /; FreeQ[{c, d}, x]

Rubi steps

$$\int \sqrt{c \csc(a + bx)} dx = (\sqrt{c \csc(a + bx)} \sqrt{\sin(a + bx)}) \int \frac{1}{\sqrt{\sin(a + bx)}} dx$$

$$= \frac{2\sqrt{c \csc(a + bx)} F\left(\frac{1}{2}\left(a - \frac{\pi}{2} + bx\right) \middle| 2\right) \sqrt{\sin(a + bx)}}{b}$$

Mathematica [A] time = 0.0355421, size = 42, normalized size = 0.98

$$\frac{2\sqrt{\sin(a + bx)} \text{EllipticF}\left(\frac{1}{4}(-2a - 2bx + \pi), 2\right) \sqrt{c \csc(a + bx)}}{b}$$

Antiderivative was successfully verified.

[In] Integrate[Sqrt[c*Csc[a + b*x]], x]

[Out] (-2*Sqrt[c*Csc[a + b*x]]*EllipticF[(-2*a + Pi - 2*b*x)/4, 2]*Sqrt[Sin[a + b*x]])/b

Maple [C] time = 0.196, size = 165, normalized size = 3.8

$$\frac{-i\sqrt{2}(-1 + \cos(bx + a))(\cos(bx + a) + 1)^2}{b(\sin(bx + a))^2} \sqrt{\frac{c}{\sin(bx + a)}} \sqrt{\frac{i \cos(bx + a) + \sin(bx + a) - i}{\sin(bx + a)}} \sqrt{\frac{i \cos(bx + a) - \sin(bx + a)}{\sin(bx + a)}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int((c*csc(b*x+a))^(1/2), x)

[Out] -I/b*2^(1/2)*(c/sin(b*x+a))^(1/2)*(-1+cos(b*x+a))*((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2)*(-(I*cos(b*x+a)-sin(b*x+a)-I)/sin(b*x+a))^(1/2)*(-I*(-1+cos(b*x+a))/sin(b*x+a))^(1/2)*EllipticF(((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2), 1/2*2^(1/2))/sin(b*x+a)^2*(cos(b*x+a)+1)^2

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \sqrt{c \csc(bx + a)} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate((c*csc(b*x+a))^(1/2),x, algorithm="maxima")`

[Out] `integrate(sqrt(c*csc(b*x + a)), x)`

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\sqrt{c \csc(bx + a)}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate((c*csc(b*x+a))^(1/2),x, algorithm="fricas")`

[Out] `integral(sqrt(c*csc(b*x + a)), x)`

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \sqrt{c \csc(a + bx)} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate((c*csc(b*x+a))**(1/2),x)`

[Out] `Integral(sqrt(c*csc(a + b*x)), x)`

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \sqrt{c \csc(bx + a)} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate((c*csc(b*x+a))^(1/2),x, algorithm="giac")`

[Out] `integrate(sqrt(c*csc(b*x + a)), x)`

$$3.21 \quad \int \frac{1}{\sqrt{c \csc(a+bx)}} dx$$

Optimal. Leaf size=43

$$\frac{2E\left(\frac{1}{2}\left(a+bx-\frac{\pi}{2}\right)\middle|2\right)}{b\sqrt{\sin(a+bx)}\sqrt{c \csc(a+bx)}}$$

[Out] (2*EllipticE[(a - Pi/2 + b*x)/2, 2])/(b*Sqrt[c*Csc[a + b*x]]*Sqrt[Sin[a + b*x]])

Rubi [A] time = 0.0180977, antiderivative size = 43, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 12, $\frac{\text{number of rules}}{\text{integrand size}} = 0.167$, Rules used = {3771, 2639}

$$\frac{2E\left(\frac{1}{2}\left(a+bx-\frac{\pi}{2}\right)\middle|2\right)}{b\sqrt{\sin(a+bx)}\sqrt{c \csc(a+bx)}}$$

Antiderivative was successfully verified.

[In] Int[1/Sqrt[c*Csc[a + b*x]],x]

[Out] (2*EllipticE[(a - Pi/2 + b*x)/2, 2])/(b*Sqrt[c*Csc[a + b*x]]*Sqrt[Sin[a + b*x]])

Rule 3771

Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Dist[(b*Csc[c + d*x])^n*Sin[c + d*x]^n, Int[1/Sin[c + d*x]^n, x], x] /; FreeQ[{b, c, d}, x] && EqQ[n^2, 1/4]

Rule 2639

Int[Sqrt[sin[(c_.) + (d_.)*(x_)]], x_Symbol] := Simp[(2*EllipticE[(1*(c - Pi/2 + d*x))/2, 2])/d, x] /; FreeQ[{c, d}, x]

Rubi steps

$$\frac{\sin(bx+a)-I}{\sin(bx+a)}^{1/2}, 1/2 \cdot 2^{1/2}) * (-I * (-1 + \cos(bx+a)) / \sin(bx+a))^{1/2} * ((-I \cos(bx+a) + \sin(bx+a) + I) / \sin(bx+a))^{1/2} * ((I \cos(bx+a) + \sin(bx+a) - I) / \sin(bx+a))^{1/2} + 2^{1/2} * \cos(bx+a) - 2^{1/2}) / (c / \sin(bx+a))^{1/2} / \sin(bx+a)$$

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\sqrt{c \csc(bx + a)}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(c*csc(b*x+a))^(1/2),x, algorithm="maxima")

[Out] integrate(1/sqrt(c*csc(b*x + a)), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\frac{\sqrt{c \csc(bx + a)}}{c \csc(bx + a)}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(c*csc(b*x+a))^(1/2),x, algorithm="fricas")

[Out] integral(sqrt(c*csc(b*x + a))/(c*csc(b*x + a)), x)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\sqrt{c \csc(a + bx)}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(c*csc(b*x+a))**(1/2),x)

[Out] Integral(1/sqrt(c*csc(a + b*x)), x)

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\sqrt{c \csc(bx + a)}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(c*csc(b*x+a))^(1/2),x, algorithm="giac")

[Out] integrate(1/sqrt(c*csc(b*x + a)), x)

$$3.22 \quad \int \frac{1}{(c \csc(a+bx))^{3/2}} dx$$

Optimal. Leaf size=77

$$\frac{2\sqrt{\sin(a+bx)}\text{EllipticF}\left(\frac{1}{2}\left(a+bx-\frac{\pi}{2}\right), 2\right)\sqrt{c \csc(a+bx)}}{3bc^2} - \frac{2 \cos(a+bx)}{3bc\sqrt{c \csc(a+bx)}}$$

[Out] (-2*Cos[a + b*x])/(3*b*c*Sqrt[c*Csc[a + b*x]]) + (2*Sqrt[c*Csc[a + b*x]]*EllipticF[(a - Pi/2 + b*x)/2, 2]*Sqrt[Sin[a + b*x]])/(3*b*c^2)

Rubi [A] time = 0.032662, antiderivative size = 77, normalized size of antiderivative = 1., number of steps used = 3, number of rules used = 3, integrand size = 12, $\frac{\text{number of rules}}{\text{integrand size}} = 0.25$, Rules used = {3769, 3771, 2641}

$$\frac{2\sqrt{\sin(a+bx)}F\left(\frac{1}{2}\left(a+bx-\frac{\pi}{2}\right)\middle|2\right)\sqrt{c \csc(a+bx)}}{3bc^2} - \frac{2 \cos(a+bx)}{3bc\sqrt{c \csc(a+bx)}}$$

Antiderivative was successfully verified.

[In] Int[(c*Csc[a + b*x])^(-3/2), x]

[Out] (-2*Cos[a + b*x])/(3*b*c*Sqrt[c*Csc[a + b*x]]) + (2*Sqrt[c*Csc[a + b*x]]*EllipticF[(a - Pi/2 + b*x)/2, 2]*Sqrt[Sin[a + b*x]])/(3*b*c^2)

Rule 3769

```
Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Simp[(Cos[c + d*x]*(b*Csc[c + d*x])^(n + 1))/(b*d^n), x] + Dist[(n + 1)/(b^2*n), Int[(b*Csc[c + d*x])^(n + 2), x], x] /; FreeQ[{b, c, d}, x] && LtQ[n, -1] && IntegerQ[2*n]
```

Rule 3771

```
Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Dist[(b*Csc[c + d*x])^n*Sin[c + d*x]^n, Int[1/Sin[c + d*x]^n, x], x] /; FreeQ[{b, c, d}, x] && EqQ[n^2, 1/4]
```

Rule 2641

```
Int[1/Sqrt[sin[(c_.) + (d_.)*(x_.)], x_Symbol] := Simp[(2*EllipticF[(1*(c - Pi/2 + d*x))/2, 2])/d, x] /; FreeQ[{c, d}, x]
```

Rubi steps

$$\begin{aligned} \int \frac{1}{(c \csc(a + bx))^{3/2}} dx &= -\frac{2 \cos(a + bx)}{3bc\sqrt{c \csc(a + bx)}} + \frac{\int \sqrt{c \csc(a + bx)} dx}{3c^2} \\ &= -\frac{2 \cos(a + bx)}{3bc\sqrt{c \csc(a + bx)}} + \frac{(\sqrt{c \csc(a + bx)}\sqrt{\sin(a + bx)}) \int \frac{1}{\sqrt{\sin(a + bx)}} dx}{3c^2} \\ &= -\frac{2 \cos(a + bx)}{3bc\sqrt{c \csc(a + bx)}} + \frac{2\sqrt{c \csc(a + bx)}F\left(\frac{1}{2}\left(a - \frac{\pi}{2} + bx\right)\middle|2\right)\sqrt{\sin(a + bx)}}{3bc^2} \end{aligned}$$

Mathematica [A] time = 0.0823655, size = 63, normalized size = 0.82

$$-\frac{\csc^2(a + bx) \left(2\sqrt{\sin(a + bx)} \text{EllipticF}\left(\frac{1}{4}(-2a - 2bx + \pi), 2\right) + \sin(2(a + bx)) \right)}{3b(c \csc(a + bx))^{3/2}}$$

Antiderivative was successfully verified.

```
[In] Integrate[(c*Csc[a + b*x])^(-3/2), x]
```

```
[Out] -(Csc[a + b*x]^2*(2*EllipticF[(-2*a + Pi - 2*b*x)/4, 2]*Sqrt[Sin[a + b*x]] + Sin[2*(a + b*x)])/(3*b*(c*Csc[a + b*x])^(3/2))
```

Maple [C] time = 0.215, size = 189, normalized size = 2.5

$$-\frac{\sqrt{2}}{3b(-1 + \cos(bx + a)) \sin(bx + a)} \left(i \sqrt{\frac{i \cos(bx + a) + \sin(bx + a) - i}{\sin(bx + a)}} \sqrt{\frac{-i(-1 + \cos(bx + a))}{\sin(bx + a)}} \sqrt{\frac{i \cos(bx + a) - \sin(bx + a)}{\sin(bx + a)}} \right)$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] int(1/(c*csc(b*x+a))^(3/2), x)
```

```
[Out] -1/3/b*2^(1/2)*(I*((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2)*(-I*(-1+cos(b*x+a))/sin(b*x+a))^(1/2)*(-I*cos(b*x+a)-sin(b*x+a)-I)/sin(b*x+a))^(1/2)
```

```
*sin(b*x+a)*EllipticF(((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2),1/2*2^(1/2))+2^(1/2)*cos(b*x+a)^2-2^(1/2)*cos(b*x+a))/(-1+cos(b*x+a))/(c/sin(b*x+a))^(3/2)/sin(b*x+a)
```

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(c \csc(bx + a))^{\frac{3}{2}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/(c*csc(b*x+a))^(3/2),x, algorithm="maxima")
```

```
[Out] integrate((c*csc(b*x + a))^(-3/2), x)
```

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\frac{\sqrt{c \csc(bx + a)}}{c^2 \csc(bx + a)^2}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/(c*csc(b*x+a))^(3/2),x, algorithm="fricas")
```

```
[Out] integral(sqrt(c*csc(b*x + a))/(c^2*csc(b*x + a)^2), x)
```

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(c \csc(a + bx))^{\frac{3}{2}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/(c*csc(b*x+a)**(3/2),x)
```

```
[Out] Integral((c*csc(a + b*x))**(-3/2), x)
```

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(c \csc(bx + a))^{\frac{3}{2}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(c*csc(b*x+a))^(3/2),x, algorithm="giac")

[Out] integrate((c*csc(b*x + a))^(-3/2), x)

$$3.23 \quad \int \frac{1}{(c \csc(a+bx))^{5/2}} dx$$

Optimal. Leaf size=77

$$\frac{6E\left(\frac{1}{2}\left(a+bx-\frac{\pi}{2}\right)\middle|2\right)}{5bc^2\sqrt{\sin(a+bx)}\sqrt{c \csc(a+bx)}} - \frac{2 \cos(a+bx)}{5bc(c \csc(a+bx))^{3/2}}$$

[Out] $(-2*\text{Cos}[a + b*x])/(5*b*c*(c*\text{Csc}[a + b*x])^{(3/2)}) + (6*\text{EllipticE}[(a - \text{Pi}/2 + b*x)/2, 2])/(5*b*c^2*\text{Sqrt}[c*\text{Csc}[a + b*x]]*\text{Sqrt}[\text{Sin}[a + b*x]])$

Rubi [A] time = 0.0319249, antiderivative size = 77, normalized size of antiderivative = 1., number of steps used = 3, number of rules used = 3, integrand size = 12, $\frac{\text{number of rules}}{\text{integrand size}} = 0.25$, Rules used = {3769, 3771, 2639}

$$\frac{6E\left(\frac{1}{2}\left(a+bx-\frac{\pi}{2}\right)\middle|2\right)}{5bc^2\sqrt{\sin(a+bx)}\sqrt{c \csc(a+bx)}} - \frac{2 \cos(a+bx)}{5bc(c \csc(a+bx))^{3/2}}$$

Antiderivative was successfully verified.

[In] $\text{Int}[(c*\text{Csc}[a + b*x])^{(-5/2)}, x]$

[Out] $(-2*\text{Cos}[a + b*x])/(5*b*c*(c*\text{Csc}[a + b*x])^{(3/2)}) + (6*\text{EllipticE}[(a - \text{Pi}/2 + b*x)/2, 2])/(5*b*c^2*\text{Sqrt}[c*\text{Csc}[a + b*x]]*\text{Sqrt}[\text{Sin}[a + b*x]])$

Rule 3769

```
Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Simp[(Cos[c + d*x]*(
b*Csc[c + d*x])^(n + 1))/(b*d*n), x] + Dist[(n + 1)/(b^2*n), Int[(b*Csc[c +
d*x])^(n + 2), x], x] /; FreeQ[{b, c, d}, x] && LtQ[n, -1] && IntegerQ[2*n
]
```

Rule 3771

```
Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Dist[(b*Csc[c + d*x]
)^(n)*Sin[c + d*x]^n, Int[1/Sin[c + d*x]^n, x], x] /; FreeQ[{b, c, d}, x] &&
EqQ[n^2, 1/4]
```

Rule 2639

```
Int[Sqrt[sin[(c_.) + (d_.)*(x_)]], x_Symbol] := Simp[(2*EllipticE[(1*(c - P
i/2 + d*x))/2, 2])/d, x] /; FreeQ[{c, d}, x]
```

Rubi steps

$$\begin{aligned} \int \frac{1}{(c \csc(a + bx))^{5/2}} dx &= -\frac{2 \cos(a + bx)}{5bc(c \csc(a + bx))^{3/2}} + \frac{3 \int \frac{1}{\sqrt{c \csc(a + bx)}} dx}{5c^2} \\ &= -\frac{2 \cos(a + bx)}{5bc(c \csc(a + bx))^{3/2}} + \frac{3 \int \sqrt{\sin(a + bx)} dx}{5c^2 \sqrt{c \csc(a + bx)} \sqrt{\sin(a + bx)}} \\ &= -\frac{2 \cos(a + bx)}{5bc(c \csc(a + bx))^{3/2}} + \frac{6E\left(\frac{1}{2}\left(a - \frac{\pi}{2} + bx\right)\middle|2\right)}{5bc^2 \sqrt{c \csc(a + bx)} \sqrt{\sin(a + bx)}} \end{aligned}$$

Mathematica [A] time = 0.143341, size = 60, normalized size = 0.78

$$\frac{-2 \sin(2(a + bx)) - \frac{12E\left(\frac{1}{4}(-2a - 2bx + \pi)\middle|2\right)}{\sqrt{\sin(a + bx)}}}{10bc^2 \sqrt{c \csc(a + bx)}}$$

Antiderivative was successfully verified.

```
[In] Integrate[(c*Csc[a + b*x])^(-5/2), x]
```

```
[Out] ((-12*EllipticE[(-2*a + Pi - 2*b*x)/4, 2])/Sqrt[Sin[a + b*x]] - 2*Sin[2*(a
+ b*x)])/(10*b*c^2*Sqrt[c*Csc[a + b*x]])
```

Maple [C] time = 0.252, size = 547, normalized size = 7.1

result too large to display

Verification of antiderivative is not currently implemented for this CAS.

```
[In] int(1/(c*csc(b*x+a))^(5/2), x)
```

```
[Out] -1/5/b*2^(1/2)*(6*((I*cos(b*x+a)+sin(b*x+a)-I)/sin(b*x+a))^(1/2)*(-(I*cos(b
*x+a)-sin(b*x+a)-I)/sin(b*x+a))^(1/2)*EllipticE(((I*cos(b*x+a)+sin(b*x+a)-I
)/sin(b*x+a))^(1/2), 1/2*2^(1/2))*(-I*(-1+cos(b*x+a))/sin(b*x+a))^(1/2)*cos(
```

$$b*x+a)-3*((I*\cos(b*x+a)+\sin(b*x+a)-I)/\sin(b*x+a))^{(1/2)}*(-(I*\cos(b*x+a)-\sin(b*x+a)-I)/\sin(b*x+a))^{(1/2)}*EllipticF(((I*\cos(b*x+a)+\sin(b*x+a)-I)/\sin(b*x+a))^{(1/2)},1/2*2^{(1/2)})*(-I*(-1+\cos(b*x+a))/\sin(b*x+a))^{(1/2)}*\cos(b*x+a)+6*(-I*(-1+\cos(b*x+a))/\sin(b*x+a))^{(1/2)}*((I*\cos(b*x+a)+\sin(b*x+a)-I)/\sin(b*x+a))^{(1/2)}*(-(I*\cos(b*x+a)-\sin(b*x+a)-I)/\sin(b*x+a))^{(1/2)}*EllipticE(((I*\cos(b*x+a)+\sin(b*x+a)-I)/\sin(b*x+a))^{(1/2)},1/2*2^{(1/2)})-3*(-I*(-1+\cos(b*x+a))/\sin(b*x+a))^{(1/2)}*((I*\cos(b*x+a)+\sin(b*x+a)-I)/\sin(b*x+a))^{(1/2)}*(-(I*\cos(b*x+a)-\sin(b*x+a)-I)/\sin(b*x+a))^{(1/2)}*EllipticF(((I*\cos(b*x+a)+\sin(b*x+a)-I)/\sin(b*x+a))^{(1/2)},1/2*2^{(1/2)})-2^{(1/2)}*\cos(b*x+a)^3+4*2^{(1/2)}*\cos(b*x+a)-3*2^{(1/2)})/(c/\sin(b*x+a))^{(5/2)}/\sin(b*x+a)^3$$

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(c \csc (bx + a))^{\frac{5}{2}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(c*csc(b*x+a))^(5/2),x, algorithm="maxima")

[Out] integrate((c*csc(b*x + a))^(-5/2), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\frac{\sqrt{c \csc (bx + a)}}{c^3 \csc (bx + a)^3}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(c*csc(b*x+a))^(5/2),x, algorithm="fricas")

[Out] integral(sqrt(c*csc(b*x + a))/(c^3*csc(b*x + a)^3), x)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(c \csc (a + bx))^{\frac{5}{2}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(c*csc(b*x+a))**(5/2),x)

[Out] Integral((c*csc(a + b*x))**(-5/2), x)

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(c \csc(bx + a))^{\frac{5}{2}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(c*csc(b*x+a))^(5/2),x, algorithm="giac")

[Out] integrate((c*csc(b*x + a))^(5/2), x)

$$3.24 \quad \int \frac{1}{(c \csc(a+bx))^{7/2}} dx$$

Optimal. Leaf size=105

$$\frac{10\sqrt{\sin(a+bx)}\text{EllipticF}\left(\frac{1}{2}\left(a+bx-\frac{\pi}{2}\right), 2\right)\sqrt{c \csc(a+bx)}}{21bc^4} - \frac{10 \cos(a+bx)}{21bc^3\sqrt{c \csc(a+bx)}} - \frac{2 \cos(a+bx)}{7bc(c \csc(a+bx))^{5/2}}$$

[Out] (-2*Cos[a + b*x])/(7*b*c*(c*Csc[a + b*x])^(5/2)) - (10*Cos[a + b*x])/(21*b*c^3*Sqrt[c*Csc[a + b*x]]) + (10*Sqrt[c*Csc[a + b*x]]*EllipticF[(a - Pi/2 + b*x)/2, 2]*Sqrt[Sin[a + b*x]])/(21*b*c^4)

Rubi [A] time = 0.0491781, antiderivative size = 105, normalized size of antiderivative = 1., number of steps used = 4, number of rules used = 3, integrand size = 12, $\frac{\text{number of rules}}{\text{integrand size}} = 0.25$, Rules used = {3769, 3771, 2641}

$$-\frac{10 \cos(a+bx)}{21bc^3\sqrt{c \csc(a+bx)}} + \frac{10\sqrt{\sin(a+bx)}F\left(\frac{1}{2}\left(a+bx-\frac{\pi}{2}\right)\middle|2\right)\sqrt{c \csc(a+bx)}}{21bc^4} - \frac{2 \cos(a+bx)}{7bc(c \csc(a+bx))^{5/2}}$$

Antiderivative was successfully verified.

[In] Int[(c*Csc[a + b*x])^(-7/2), x]

[Out] (-2*Cos[a + b*x])/(7*b*c*(c*Csc[a + b*x])^(5/2)) - (10*Cos[a + b*x])/(21*b*c^3*Sqrt[c*Csc[a + b*x]]) + (10*Sqrt[c*Csc[a + b*x]]*EllipticF[(a - Pi/2 + b*x)/2, 2]*Sqrt[Sin[a + b*x]])/(21*b*c^4)

Rule 3769

```
Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Simp[(Cos[c + d*x]*(b*Csc[c + d*x])^(n + 1))/(b*d*n), x] + Dist[(n + 1)/(b^2*n), Int[(b*Csc[c + d*x])^(n + 2), x], x] /; FreeQ[{b, c, d}, x] && LtQ[n, -1] && IntegerQ[2*n]
```

Rule 3771

```
Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Dist[(b*Csc[c + d*x])^n*Sin[c + d*x]^n, Int[1/Sin[c + d*x]^n, x], x] /; FreeQ[{b, c, d}, x] && EqQ[n^2, 1/4]
```

Rule 2641

Int[1/Sqrt[sin[(c_.) + (d_.)*(x_)]], x_Symbol] := Simp[(2*EllipticF[(1*(c - Pi/2 + d*x))/2, 2])/d, x] /; FreeQ[{c, d}, x]

Rubi steps

$$\begin{aligned} \int \frac{1}{(c \csc(a + bx))^{7/2}} dx &= -\frac{2 \cos(a + bx)}{7bc(c \csc(a + bx))^{5/2}} + \frac{5 \int \frac{1}{(c \csc(a + bx))^{3/2}} dx}{7c^2} \\ &= -\frac{2 \cos(a + bx)}{7bc(c \csc(a + bx))^{5/2}} - \frac{10 \cos(a + bx)}{21bc^3 \sqrt{c \csc(a + bx)}} + \frac{5 \int \sqrt{c \csc(a + bx)} dx}{21c^4} \\ &= -\frac{2 \cos(a + bx)}{7bc(c \csc(a + bx))^{5/2}} - \frac{10 \cos(a + bx)}{21bc^3 \sqrt{c \csc(a + bx)}} + \frac{(5\sqrt{c \csc(a + bx)}\sqrt{\sin(a + bx)}) \int \frac{1}{\sqrt{\sin(a + bx)}} dx}{21c^4} \\ &= -\frac{2 \cos(a + bx)}{7bc(c \csc(a + bx))^{5/2}} - \frac{10 \cos(a + bx)}{21bc^3 \sqrt{c \csc(a + bx)}} + \frac{10\sqrt{c \csc(a + bx)}F\left(\frac{1}{2}\left(a - \frac{\pi}{2} + bx\right)\middle|2\right)\sqrt{\sin(a + bx)}}{21bc^4} \end{aligned}$$

Mathematica [A] time = 0.143812, size = 70, normalized size = 0.67

$$\frac{\sqrt{c \csc(a + bx)} \left(40\sqrt{\sin(a + bx)} \text{EllipticF}\left(\frac{1}{4}(-2a - 2bx + \pi), 2\right) + 26 \sin(2(a + bx)) - 3 \sin(4(a + bx)) \right)}{84bc^4}$$

Antiderivative was successfully verified.

[In] Integrate[(c*Csc[a + b*x])^(-7/2), x]

[Out] -(Sqrt[c*Csc[a + b*x]]*(40*EllipticF[(-2*a + Pi - 2*b*x)/4, 2]*Sqrt[Sin[a + b*x]] + 26*Sin[2*(a + b*x)] - 3*Sin[4*(a + b*x)]))/(84*b*c^4)

Maple [C] time = 0.275, size = 216, normalized size = 2.1

$$\frac{\sqrt{2}}{21 b (-1 + \cos(bx + a)) (\sin(bx + a))^3} \left(5i \sqrt{\frac{-i(-1 + \cos(bx + a))}{\sin(bx + a)}} \sin(bx + a) \sqrt{\frac{i \cos(bx + a) - \sin(bx + a) - i}{\sin(bx + a)}} \text{EllipticF}\left(\frac{1}{4}(-2a - 2bx + \pi), 2\right) + 26 \sin(2(a + bx)) - 3 \sin(4(a + bx)) \right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `int(1/(c*csc(b*x+a))^(7/2),x)`

[Out]
$$-1/21/b*2^{(1/2)}*(5*I*(-I*(-1+\cos(b*x+a))/\sin(b*x+a))^{(1/2)}*\sin(b*x+a)*(-I*\cos(b*x+a)-\sin(b*x+a)-I)/\sin(b*x+a))^{(1/2)}*\text{EllipticF}(((I*\cos(b*x+a)+\sin(b*x+a)-I)/\sin(b*x+a))^{(1/2)},1/2*2^{(1/2)})*((I*\cos(b*x+a)+\sin(b*x+a)-I)/\sin(b*x+a))^{(1/2)}-3*2^{(1/2)}*\cos(b*x+a)^4+3*2^{(1/2)}*\cos(b*x+a)^3+8*2^{(1/2)}*\cos(b*x+a)^2-8*2^{(1/2)}*\cos(b*x+a))/(-1+\cos(b*x+a))/(c/\sin(b*x+a))^{(7/2)}/\sin(b*x+a)^3$$

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(c \csc (bx + a))^{\frac{7}{2}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(c*csc(b*x+a))^(7/2),x, algorithm="maxima")`

[Out] `integrate((c*csc(b*x + a))^(-7/2), x)`

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\frac{\sqrt{c \csc (bx + a)}}{c^4 \csc (bx + a)^4}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(c*csc(b*x+a))^(7/2),x, algorithm="fricas")`

[Out] `integral(sqrt(c*csc(b*x + a))/(c^4*csc(b*x + a)^4), x)`

Sympy [F(-1)] time = 0., size = 0, normalized size = 0.

Timed out

Verification of antiderivative is not currently implemented for this CAS.


```
[In] integrate(1/(c*csc(b*x+a))**(7/2),x)
```

```
[Out] Timed out
```

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(c \csc(bx + a))^{\frac{7}{2}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/(c*csc(b*x+a))^(7/2),x, algorithm="giac")
```

```
[Out] integrate((c*csc(b*x + a))^(-7/2), x)
```

3.25 $\int \csc^{\frac{4}{3}}(a + bx) dx$

Optimal. Leaf size=51

$$\frac{3 \cos(a + bx) \sqrt[3]{\csc(a + bx)} \operatorname{Hypergeometric2F1}\left(-\frac{1}{6}, \frac{1}{2}, \frac{5}{6}, \sin^2(a + bx)\right)}{b \sqrt{\cos^2(a + bx)}}$$

[Out] $(-3 \cos[a + b*x] * \operatorname{Csc}[a + b*x]^{(1/3)} * \operatorname{Hypergeometric2F1}[-1/6, 1/2, 5/6, \operatorname{Sin}[a + b*x]^2]) / (b * \operatorname{Sqrt}[\operatorname{Cos}[a + b*x]^2])$

Rubi [A] time = 0.0223791, antiderivative size = 51, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.2$, Rules used = {3772, 2643}

$$\frac{3 \cos(a + bx) \sqrt[3]{\csc(a + bx)} {}_2F_1\left(-\frac{1}{6}, \frac{1}{2}; \frac{5}{6}; \sin^2(a + bx)\right)}{b \sqrt{\cos^2(a + bx)}}$$

Antiderivative was successfully verified.

[In] $\operatorname{Int}[\operatorname{Csc}[a + b*x]^{(4/3)}, x]$

[Out] $(-3 \cos[a + b*x] * \operatorname{Csc}[a + b*x]^{(1/3)} * \operatorname{Hypergeometric2F1}[-1/6, 1/2, 5/6, \operatorname{Sin}[a + b*x]^2]) / (b * \operatorname{Sqrt}[\operatorname{Cos}[a + b*x]^2])$

Rule 3772

$\operatorname{Int}[(\operatorname{csc}[(c_.) + (d_.)*(x_.)]*(b_.))^{(n_.)}, x_Symbol] \rightarrow \operatorname{Simp}[(b * \operatorname{Csc}[c + d*x])^{(n - 1)} * ((\operatorname{Sin}[c + d*x]/b)^{(n - 1)} * \operatorname{Int}[1/(\operatorname{Sin}[c + d*x]/b)^n, x]), x] /;$ $\operatorname{FreeQ}\{b, c, d, n\}, x\} \ \&\amp; \ !\operatorname{IntegerQ}[n]$

Rule 2643

$\operatorname{Int}[(b_. * \operatorname{sin}[(c_.) + (d_.)*(x_.)])^{(n_.)}, x_Symbol] \rightarrow \operatorname{Simp}[(\operatorname{Cos}[c + d*x] * (b * \operatorname{Sin}[c + d*x])^{(n + 1)} * \operatorname{Hypergeometric2F1}[1/2, (n + 1)/2, (n + 3)/2, \operatorname{Sin}[c + d*x]^2]) / (b * d * (n + 1) * \operatorname{Sqrt}[\operatorname{Cos}[c + d*x]^2]), x] /;$ $\operatorname{FreeQ}\{b, c, d, n\}, x\} \ \&\amp; \ !\operatorname{IntegerQ}[2*n]$

Rubi steps

$$\int \csc^{\frac{4}{3}}(a + bx) dx = \sqrt[3]{\csc(a + bx)} \sqrt[3]{\sin(a + bx)} \int \frac{1}{\sin^{\frac{4}{3}}(a + bx)} dx$$

$$= -\frac{3 \cos(a + bx) \sqrt[3]{\csc(a + bx)} {}_2F_1\left(-\frac{1}{6}, \frac{1}{2}; \frac{5}{6}; \sin^2(a + bx)\right)}{b \sqrt{\cos^2(a + bx)}}$$

Mathematica [A] time = 0.0775629, size = 54, normalized size = 1.06

$$\frac{\cos(a + bx) \sqrt[3]{\csc(a + bx)} \left(2 \sqrt[6]{\sin^2(a + bx)} \text{Hypergeometric2F1}\left(\frac{1}{6}, \frac{1}{2}, \frac{3}{2}, \cos^2(a + bx)\right) - 3 \right)}{b}$$

Antiderivative was successfully verified.

[In] Integrate[Csc[a + b*x]^(4/3), x]

[Out] (Cos[a + b*x]*Csc[a + b*x]^(1/3)*(-3 + 2*Hypergeometric2F1[1/6, 1/2, 3/2, Cos[a + b*x]^2]*(Sin[a + b*x]^2)^(1/6)))/b

Maple [F] time = 0.104, size = 0, normalized size = 0.

$$\int (\csc(bx + a))^{\frac{4}{3}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(csc(b*x+a)^(4/3), x)

[Out] int(csc(b*x+a)^(4/3), x)

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \csc(bx + a)^{\frac{4}{3}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^(4/3),x, algorithm="maxima")

[Out] integrate(csc(b*x + a)^(4/3), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\text{csc}(bx + a)^{\frac{4}{3}}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^(4/3),x, algorithm="fricas")

[Out] integral(csc(b*x + a)^(4/3), x)

Sympy [F(-1)] time = 0., size = 0, normalized size = 0.

Timed out

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)**(4/3),x)

[Out] Timed out

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \text{csc}(bx + a)^{\frac{4}{3}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^(4/3),x, algorithm="giac")

[Out] integrate(csc(b*x + a)^(4/3), x)

3.26 $\int \csc^{\frac{2}{3}}(a + bx) dx$

Optimal. Leaf size=51

$$\frac{3 \cos(a + bx) \operatorname{Hypergeometric2F1}\left(\frac{1}{6}, \frac{1}{2}, \frac{7}{6}, \sin^2(a + bx)\right)}{b \sqrt{\cos^2(a + bx)} \sqrt[3]{\csc(a + bx)}}$$

[Out] (3*Cos[a + b*x]*Hypergeometric2F1[1/6, 1/2, 7/6, Sin[a + b*x]^2])/(b*Sqrt[Cos[a + b*x]^2]*Csc[a + b*x]^(1/3))

Rubi [A] time = 0.021894, antiderivative size = 51, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.2$, Rules used = {3772, 2643}

$$\frac{3 \cos(a + bx) {}_2F_1\left(\frac{1}{6}, \frac{1}{2}; \frac{7}{6}; \sin^2(a + bx)\right)}{b \sqrt{\cos^2(a + bx)} \sqrt[3]{\csc(a + bx)}}$$

Antiderivative was successfully verified.

[In] Int[Csc[a + b*x]^(2/3), x]

[Out] (3*Cos[a + b*x]*Hypergeometric2F1[1/6, 1/2, 7/6, Sin[a + b*x]^2])/(b*Sqrt[Cos[a + b*x]^2]*Csc[a + b*x]^(1/3))

Rule 3772

Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Simp[(b*Csc[c + d*x])^(n - 1)*((Sin[c + d*x]/b)^(n - 1)*Int[1/(Sin[c + d*x]/b)^n, x]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[n]

Rule 2643

Int[((b_.)*sin[(c_.) + (d_.)*(x_)])^(n_), x_Symbol] := Simp[(Cos[c + d*x]*(b*Sin[c + d*x])^(n + 1)*Hypergeometric2F1[1/2, (n + 1)/2, (n + 3)/2, Sin[c + d*x]^2])/(b*d*(n + 1)*Sqrt[Cos[c + d*x]^2]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[2*n]

Rubi steps

$$\int \csc^{\frac{2}{3}}(a + bx) dx = \csc^{\frac{2}{3}}(a + bx) \sin^{\frac{2}{3}}(a + bx) \int \frac{1}{\sin^{\frac{2}{3}}(a + bx)} dx$$

$$= \frac{3 \cos(a + bx) {}_2F_1\left(\frac{1}{6}, \frac{1}{2}; \frac{7}{6}; \sin^2(a + bx)\right)}{b \sqrt{\cos^2(a + bx)} \sqrt[3]{\csc(a + bx)}}$$

Mathematica [A] time = 0.059056, size = 51, normalized size = 1.

$$\frac{\cos(a + bx) \text{Hypergeometric2F1}\left(\frac{1}{2}, \frac{5}{6}, \frac{3}{2}, \cos^2(a + bx)\right)}{b \sqrt[6]{\sin^2(a + bx)} \sqrt[3]{\csc(a + bx)}}$$

Antiderivative was successfully verified.

[In] Integrate[Csc[a + b*x]^(2/3), x]

[Out] -((Cos[a + b*x]*Hypergeometric2F1[1/2, 5/6, 3/2, Cos[a + b*x]^2])/(b*Csc[a + b*x]^(1/3)*(Sin[a + b*x]^2)^(1/6)))

Maple [F] time = 0.145, size = 0, normalized size = 0.

$$\int (\csc(bx + a))^{\frac{2}{3}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(csc(b*x+a)^(2/3), x)

[Out] int(csc(b*x+a)^(2/3), x)

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \csc(bx + a)^{\frac{2}{3}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^(2/3),x, algorithm="maxima")

[Out] integrate(csc(b*x + a)^(2/3), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\text{csc}(bx + a)^{\frac{2}{3}}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^(2/3),x, algorithm="fricas")

[Out] integral(csc(b*x + a)^(2/3), x)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \text{csc}^{\frac{2}{3}}(a + bx) dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)**(2/3),x)

[Out] Integral(csc(a + b*x)**(2/3), x)

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \text{csc}(bx + a)^{\frac{2}{3}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^(2/3),x, algorithm="giac")

[Out] integrate(csc(b*x + a)^(2/3), x)

3.27 $\int \sqrt[3]{\csc(a + bx)} dx$

Optimal. Leaf size=53

$$\frac{3 \cos(a + bx) \operatorname{Hypergeometric2F1}\left(\frac{1}{3}, \frac{1}{2}, \frac{4}{3}, \sin^2(a + bx)\right)}{2b \sqrt{\cos^2(a + bx)} \csc^{\frac{2}{3}}(a + bx)}$$

[Out] (3*Cos[a + b*x]*Hypergeometric2F1[1/3, 1/2, 4/3, Sin[a + b*x]^2])/(2*b*Sqrt[Cos[a + b*x]^2]*Csc[a + b*x]^(2/3))

Rubi [A] time = 0.0216941, antiderivative size = 53, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.2$, Rules used = {3772, 2643}

$$\frac{3 \cos(a + bx) {}_2F_1\left(\frac{1}{3}, \frac{1}{2}; \frac{4}{3}; \sin^2(a + bx)\right)}{2b \sqrt{\cos^2(a + bx)} \csc^{\frac{2}{3}}(a + bx)}$$

Antiderivative was successfully verified.

[In] Int[Csc[a + b*x]^(1/3), x]

[Out] (3*Cos[a + b*x]*Hypergeometric2F1[1/3, 1/2, 4/3, Sin[a + b*x]^2])/(2*b*Sqrt[Cos[a + b*x]^2]*Csc[a + b*x]^(2/3))

Rule 3772

Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] :> Simp[(b*Csc[c + d*x])^(n - 1)*((Sin[c + d*x]/b)^(n - 1)*Int[1/(Sin[c + d*x]/b)^n, x]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[n]

Rule 2643

Int[((b_.)*sin[(c_.) + (d_.)*(x_)])^(n_), x_Symbol] :> Simp[(Cos[c + d*x]*(b*Sin[c + d*x])^(n + 1)*Hypergeometric2F1[1/2, (n + 1)/2, (n + 3)/2, Sin[c + d*x]^2])/(b*d*(n + 1)*Sqrt[Cos[c + d*x]^2]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[2*n]

Rubi steps

$$\int \sqrt[3]{\csc(a+bx)} dx = \sqrt[3]{\csc(a+bx)} \sqrt[3]{\sin(a+bx)} \int \frac{1}{\sqrt[3]{\sin(a+bx)}} dx$$

$$= \frac{3 \cos(a+bx) {}_2F_1\left(\frac{1}{3}, \frac{1}{2}; \frac{4}{3}; \sin^2(a+bx)\right)}{2b \sqrt{\cos^2(a+bx)} \csc^{\frac{2}{3}}(a+bx)}$$

Mathematica [A] time = 0.053962, size = 51, normalized size = 0.96

$$\frac{\cos(a+bx) \text{Hypergeometric2F1}\left(\frac{1}{2}, \frac{2}{3}, \frac{3}{2}, \cos^2(a+bx)\right)}{b \sqrt[3]{\sin^2(a+bx)} \csc^{\frac{2}{3}}(a+bx)}$$

Antiderivative was successfully verified.

[In] Integrate[Csc[a + b*x]^(1/3), x]

[Out] -((Cos[a + b*x]*Hypergeometric2F1[1/2, 2/3, 3/2, Cos[a + b*x]^2])/(b*Csc[a + b*x]^(2/3)*(Sin[a + b*x]^2)^(1/3)))

Maple [F] time = 0.166, size = 0, normalized size = 0.

$$\int \sqrt[3]{\csc(bx+a)} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(csc(b*x+a)^(1/3), x)

[Out] int(csc(b*x+a)^(1/3), x)

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \csc(bx+a)^{\frac{1}{3}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^(1/3),x, algorithm="maxima")

[Out] integrate(csc(b*x + a)^(1/3), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\text{csc}(bx + a)^{\frac{1}{3}}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^(1/3),x, algorithm="fricas")

[Out] integral(csc(b*x + a)^(1/3), x)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \sqrt[3]{\text{csc}(a + bx)} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)**(1/3),x)

[Out] Integral(csc(a + b*x)**(1/3), x)

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \text{csc}(bx + a)^{\frac{1}{3}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^(1/3),x, algorithm="giac")

[Out] integrate(csc(b*x + a)^(1/3), x)

$$3.28 \quad \int \frac{1}{\sqrt[3]{\csc(a+bx)}} dx$$

Optimal. Leaf size=53

$$\frac{3 \cos(a+bx) \operatorname{Hypergeometric2F1}\left(\frac{1}{2}, \frac{2}{3}, \frac{5}{3}, \sin^2(a+bx)\right)}{4b \sqrt{\cos^2(a+bx)} \operatorname{csc}^{\frac{4}{3}}(a+bx)}$$

[Out] (3*Cos[a + b*x]*Hypergeometric2F1[1/2, 2/3, 5/3, Sin[a + b*x]^2])/(4*b*Sqrt[Cos[a + b*x]^2]*Csc[a + b*x]^(4/3))

Rubi [A] time = 0.0213129, antiderivative size = 53, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.2$, Rules used = {3772, 2643}

$$\frac{3 \cos(a+bx) {}_2F_1\left(\frac{1}{2}, \frac{2}{3}; \frac{5}{3}; \sin^2(a+bx)\right)}{4b \sqrt{\cos^2(a+bx)} \operatorname{csc}^{\frac{4}{3}}(a+bx)}$$

Antiderivative was successfully verified.

[In] Int[Csc[a + b*x]^(-1/3), x]

[Out] (3*Cos[a + b*x]*Hypergeometric2F1[1/2, 2/3, 5/3, Sin[a + b*x]^2])/(4*b*Sqrt[Cos[a + b*x]^2]*Csc[a + b*x]^(4/3))

Rule 3772

Int[(csc[(c_.) + (d_.)*(x_)])*(b_.)]^(n_), x_Symbol] :> Simp[(b*Csc[c + d*x])^(n - 1)*((Sin[c + d*x]/b)^(n - 1)*Int[1/((Sin[c + d*x]/b)^n, x]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[n]

Rule 2643

Int[((b_.)*sin[(c_.) + (d_.)*(x_)])^(n_), x_Symbol] :> Simp[(Cos[c + d*x]*(b*Sin[c + d*x])^(n + 1)*Hypergeometric2F1[1/2, (n + 1)/2, (n + 3)/2, Sin[c + d*x]^2])/(b*d*(n + 1)*Sqrt[Cos[c + d*x]^2]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[2*n]

Rubi steps

$$\int \frac{1}{\sqrt[3]{\csc(a+bx)}} dx = \csc^{\frac{2}{3}}(a+bx) \sin^{\frac{2}{3}}(a+bx) \int \sqrt[3]{\sin(a+bx)} dx$$

$$= \frac{3 \cos(a+bx) {}_2F_1\left(\frac{1}{2}, \frac{2}{3}; \frac{5}{3}; \sin^2(a+bx)\right)}{4b\sqrt{\cos^2(a+bx)} \csc^{\frac{4}{3}}(a+bx)}$$

Mathematica [A] time = 0.0482041, size = 51, normalized size = 0.96

$$\frac{\cos(a+bx) \text{Hypergeometric2F1}\left(\frac{1}{3}, \frac{1}{2}, \frac{3}{2}, \cos^2(a+bx)\right)}{b \sin^2(a+bx)^{2/3} \csc^{\frac{4}{3}}(a+bx)}$$

Antiderivative was successfully verified.

[In] Integrate[Csc[a + b*x]^(-1/3), x]

[Out] -((Cos[a + b*x]*Hypergeometric2F1[1/3, 1/2, 3/2, Cos[a + b*x]^2])/(b*Csc[a + b*x]^(4/3)*(Sin[a + b*x]^2)^(2/3)))

Maple [F] time = 0.143, size = 0, normalized size = 0.

$$\int \frac{1}{\sqrt[3]{\csc(bx+a)}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(1/csc(b*x+a)^(1/3), x)

[Out] int(1/csc(b*x+a)^(1/3), x)

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\csc(bx+a)^{\frac{1}{3}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/csc(b*x+a)^(1/3),x, algorithm="maxima")
```

```
[Out] integrate(csc(b*x + a)^(-1/3), x)
```

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\frac{1}{\csc(bx + a)^{\frac{1}{3}}}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/csc(b*x+a)^(1/3),x, algorithm="fricas")
```

```
[Out] integral(csc(b*x + a)^(-1/3), x)
```

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\sqrt[3]{\csc(a + bx)}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/csc(b*x+a)**(1/3),x)
```

```
[Out] Integral(csc(a + b*x)**(-1/3), x)
```

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\csc(bx + a)^{\frac{1}{3}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/csc(b*x+a)^(1/3),x, algorithm="giac")
```

```
[Out] integrate(csc(b*x + a)^(-1/3), x)
```

$$3.29 \quad \int \frac{1}{\csc^{\frac{2}{3}}(a+bx)} dx$$

Optimal. Leaf size=53

$$\frac{3 \cos(a+bx) \operatorname{Hypergeometric2F1}\left(\frac{1}{2}, \frac{5}{6}, \frac{11}{6}, \sin^2(a+bx)\right)}{5b \sqrt{\cos^2(a+bx)} \csc^{\frac{5}{3}}(a+bx)}$$

[Out] (3*Cos[a + b*x]*Hypergeometric2F1[1/2, 5/6, 11/6, Sin[a + b*x]^2])/(5*b*Sqrt[Cos[a + b*x]^2]*Csc[a + b*x]^(5/3))

Rubi [A] time = 0.0212965, antiderivative size = 53, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.2$, Rules used = {3772, 2643}

$$\frac{3 \cos(a+bx) {}_2F_1\left(\frac{1}{2}, \frac{5}{6}; \frac{11}{6}; \sin^2(a+bx)\right)}{5b \sqrt{\cos^2(a+bx)} \csc^{\frac{5}{3}}(a+bx)}$$

Antiderivative was successfully verified.

[In] Int[Csc[a + b*x]^(-2/3), x]

[Out] (3*Cos[a + b*x]*Hypergeometric2F1[1/2, 5/6, 11/6, Sin[a + b*x]^2])/(5*b*Sqrt[Cos[a + b*x]^2]*Csc[a + b*x]^(5/3))

Rule 3772

Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^n], x_Symbol] :> Simp[(b*Csc[c + d*x])^(n - 1)*((Sin[c + d*x]/b)^(n - 1)*Int[1/(Sin[c + d*x]/b)^n, x]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[n]

Rule 2643

Int[((b_.)*sin[(c_.) + (d_.)*(x_)])^n], x_Symbol] :> Simp[(Cos[c + d*x]*(b*SIN[c + d*x])^(n + 1)*Hypergeometric2F1[1/2, (n + 1)/2, (n + 3)/2, Sin[c + d*x]^2])/(b*d*(n + 1)*Sqrt[Cos[c + d*x]^2]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[2*n]

Rubi steps

$$\int \frac{1}{\csc^{\frac{2}{3}}(a+bx)} dx = \sqrt[3]{\csc(a+bx)} \sqrt[3]{\sin(a+bx)} \int \sin^{\frac{2}{3}}(a+bx) dx$$

$$= \frac{3 \cos(a+bx) {}_2F_1\left(\frac{1}{2}, \frac{5}{6}; \frac{11}{6}; \sin^2(a+bx)\right)}{5b \sqrt{\cos^2(a+bx)} \csc^{\frac{5}{3}}(a+bx)}$$

Mathematica [A] time = 0.0934955, size = 51, normalized size = 0.96

$$-\frac{\cos(a+bx) \text{Hypergeometric2F1}\left(\frac{1}{6}, \frac{1}{2}, \frac{3}{2}, \cos^2(a+bx)\right)}{b \sin^2(a+bx)^{5/6} \csc^{\frac{5}{3}}(a+bx)}$$

Antiderivative was successfully verified.

[In] Integrate[Csc[a + b*x]^(-2/3), x]

[Out] -((Cos[a + b*x]*Hypergeometric2F1[1/6, 1/2, 3/2, Cos[a + b*x]^2])/(b*Csc[a + b*x]^(5/3)*(Sin[a + b*x]^2)^(5/6)))

Maple [F] time = 0.142, size = 0, normalized size = 0.

$$\int (\csc(bx+a))^{-\frac{2}{3}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(1/csc(b*x+a)^(2/3), x)

[Out] int(1/csc(b*x+a)^(2/3), x)

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\csc(bx+a)^{\frac{2}{3}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/csc(b*x+a)^(2/3),x, algorithm="maxima")
```

```
[Out] integrate(csc(b*x + a)^(-2/3), x)
```

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\frac{1}{\csc(bx+a)^{\frac{2}{3}}}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/csc(b*x+a)^(2/3),x, algorithm="fricas")
```

```
[Out] integral(csc(b*x + a)^(-2/3), x)
```

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\csc^{\frac{2}{3}}(a+bx)} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/csc(b*x+a)**(2/3),x)
```

```
[Out] Integral(csc(a + b*x)**(-2/3), x)
```

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\csc(bx+a)^{\frac{2}{3}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/csc(b*x+a)^(2/3),x, algorithm="giac")
```

```
[Out] integrate(csc(b*x + a)^(-2/3), x)
```


$$3.30 \quad \int \frac{1}{\csc^{\frac{4}{3}}(a+bx)} dx$$

Optimal. Leaf size=53

$$\frac{3 \cos(a+bx) \operatorname{Hypergeometric2F1}\left(\frac{1}{2}, \frac{7}{6}, \frac{13}{6}, \sin^2(a+bx)\right)}{7b \sqrt{\cos^2(a+bx)} \csc^{\frac{7}{3}}(a+bx)}$$

[Out] (3*Cos[a + b*x]*Hypergeometric2F1[1/2, 7/6, 13/6, Sin[a + b*x]^2])/(7*b*Sqrt[Cos[a + b*x]^2]*Csc[a + b*x]^(7/3))

Rubi [A] time = 0.0213212, antiderivative size = 53, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.2$, Rules used = {3772, 2643}

$$\frac{3 \cos(a+bx) {}_2F_1\left(\frac{1}{2}, \frac{7}{6}; \frac{13}{6}; \sin^2(a+bx)\right)}{7b \sqrt{\cos^2(a+bx)} \csc^{\frac{7}{3}}(a+bx)}$$

Antiderivative was successfully verified.

[In] Int[Csc[a + b*x]^(-4/3), x]

[Out] (3*Cos[a + b*x]*Hypergeometric2F1[1/2, 7/6, 13/6, Sin[a + b*x]^2])/(7*b*Sqrt[Cos[a + b*x]^2]*Csc[a + b*x]^(7/3))

Rule 3772

Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Simp[(b*Csc[c + d*x])^(n - 1)*((Sin[c + d*x]/b)^(n - 1)*Int[1/(Sin[c + d*x]/b)^n, x]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[n]

Rule 2643

Int[((b_.)*sin[(c_.) + (d_.)*(x_)])^(n_), x_Symbol] := Simp[(Cos[c + d*x]*(b*Sin[c + d*x])^(n + 1)*Hypergeometric2F1[1/2, (n + 1)/2, (n + 3)/2, Sin[c + d*x]^2])/(b*d*(n + 1)*Sqrt[Cos[c + d*x]^2]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[2*n]

Rubi steps

$$\int \frac{1}{\csc^{\frac{4}{3}}(a+bx)} dx = \csc^{\frac{2}{3}}(a+bx) \sin^{\frac{2}{3}}(a+bx) \int \sin^{\frac{4}{3}}(a+bx) dx$$

$$= \frac{3 \cos(a+bx) {}_2F_1\left(\frac{1}{2}, \frac{7}{6}; \frac{13}{6}; \sin^2(a+bx)\right)}{7b\sqrt{\cos^2(a+bx)} \csc^{\frac{7}{3}}(a+bx)}$$

Mathematica [A] time = 0.142166, size = 68, normalized size = 1.28

$$\frac{\cos(a+bx) \left(\text{Hypergeometric2F1}\left(\frac{1}{2}, \frac{5}{6}, \frac{3}{2}, \cos^2(a+bx)\right) + 3\sqrt[6]{\sin^2(a+bx)} \right)}{4b\sqrt[6]{\sin^2(a+bx)}\sqrt[3]{\csc(a+bx)}}$$

Antiderivative was successfully verified.

[In] Integrate[Csc[a + b*x]^(-4/3), x]

[Out] -(Cos[a + b*x]*(Hypergeometric2F1[1/2, 5/6, 3/2, Cos[a + b*x]^2] + 3*(Sin[a + b*x]^2)^(1/6)))/(4*b*Csc[a + b*x]^(1/3)*(Sin[a + b*x]^2)^(1/6))

Maple [F] time = 0.09, size = 0, normalized size = 0.

$$\int (\csc(bx+a))^{-\frac{4}{3}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(1/csc(b*x+a)^(4/3), x)

[Out] int(1/csc(b*x+a)^(4/3), x)

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\csc(bx+a)^{\frac{4}{3}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/csc(b*x+a)^(4/3),x, algorithm="maxima")
```

```
[Out] integrate(csc(b*x + a)^(-4/3), x)
```

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\frac{1}{\csc(bx+a)^{\frac{4}{3}}}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/csc(b*x+a)^(4/3),x, algorithm="fricas")
```

```
[Out] integral(csc(b*x + a)^(-4/3), x)
```

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\csc^{\frac{4}{3}}(a+bx)} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/csc(b*x+a)**(4/3),x)
```

```
[Out] Integral(csc(a + b*x)**(-4/3), x)
```

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\csc(bx+a)^{\frac{4}{3}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/csc(b*x+a)^(4/3),x, algorithm="giac")
```

```
[Out] integrate(csc(b*x + a)^(-4/3), x)
```

3.31 $\int (c \csc(a + bx))^{4/3} dx$

Optimal. Leaf size=54

$$\frac{3c \cos(a + bx) \sqrt[3]{c \csc(a + bx)} \operatorname{Hypergeometric2F1}\left(-\frac{1}{6}, \frac{1}{2}, \frac{5}{6}, \sin^2(a + bx)\right)}{b \sqrt{\cos^2(a + bx)}}$$

[Out] $(-3*c*\cos[a + b*x]*(c*\csc[a + b*x])^{(1/3)}*\operatorname{Hypergeometric2F1}[-1/6, 1/2, 5/6, \sin[a + b*x]^2])/(b*\sqrt{\cos[a + b*x]^2})$

Rubi [A] time = 0.0295966, antiderivative size = 54, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 12, $\frac{\text{number of rules}}{\text{integrand size}} = 0.167$, Rules used = {3772, 2643}

$$\frac{3c \cos(a + bx) \sqrt[3]{c \csc(a + bx)} {}_2F_1\left(-\frac{1}{6}, \frac{1}{2}; \frac{5}{6}; \sin^2(a + bx)\right)}{b \sqrt{\cos^2(a + bx)}}$$

Antiderivative was successfully verified.

[In] $\operatorname{Int}[(c*\csc[a + b*x])^{(4/3)}, x]$

[Out] $(-3*c*\cos[a + b*x]*(c*\csc[a + b*x])^{(1/3)}*\operatorname{Hypergeometric2F1}[-1/6, 1/2, 5/6, \sin[a + b*x]^2])/(b*\sqrt{\cos[a + b*x]^2})$

Rule 3772

$\operatorname{Int}[(\csc[(c_.) + (d_.)*(x_.)]*(b_.))^{(n_.)}, x_Symbol] \rightarrow \operatorname{Simp}[(b*\csc[c + d*x])^{(n - 1)}*((\sin[c + d*x]/b)^{(n - 1)}*\operatorname{Int}[1/(\sin[c + d*x]/b)^n, x]), x] /;$ $\operatorname{FreeQ}\{b, c, d, n\}, x] \ \&\amp; \ !\operatorname{IntegerQ}[n]$

Rule 2643

$\operatorname{Int}[(b_.)*\sin[(c_.) + (d_.)*(x_.)]^{(n_.)}, x_Symbol] \rightarrow \operatorname{Simp}[(\cos[c + d*x]*(b*\sin[c + d*x])^{(n + 1)}*\operatorname{Hypergeometric2F1}[1/2, (n + 1)/2, (n + 3)/2, \sin[c + d*x]^2])/(b*d*(n + 1)*\sqrt{\cos[c + d*x]^2}), x] /;$ $\operatorname{FreeQ}\{b, c, d, n\}, x] \ \&\amp; \ !\operatorname{IntegerQ}[2*n]$

Rubi steps

$$\int (c \csc(a + bx))^{4/3} dx = \sqrt[3]{c \csc(a + bx)} \sqrt[3]{\frac{\sin(a + bx)}{c}} \int \frac{1}{\left(\frac{\sin(a+bx)}{c}\right)^{4/3}} dx$$

$$= -\frac{3c \cos(a + bx) \sqrt[3]{c \csc(a + bx)} {}_2F_1\left(-\frac{1}{6}, \frac{1}{2}; \frac{5}{6}; \sin^2(a + bx)\right)}{b \sqrt{\cos^2(a + bx)}}$$

Mathematica [A] time = 0.0465348, size = 57, normalized size = 1.06

$$\frac{c \cos(a + bx) \sqrt[3]{c \csc(a + bx)} \left(2 \sqrt[6]{\sin^2(a + bx)} \text{Hypergeometric2F1}\left(\frac{1}{6}, \frac{1}{2}, \frac{3}{2}, \cos^2(a + bx)\right) - 3\right)}{b}$$

Antiderivative was successfully verified.

[In] Integrate[(c*Csc[a + b*x])^(4/3), x]

[Out] (c*Cos[a + b*x]*(c*Csc[a + b*x])^(1/3)*(-3 + 2*Hypergeometric2F1[1/6, 1/2, 3/2, Cos[a + b*x]^2]*(Sin[a + b*x]^2)^(1/6)))/b

Maple [F] time = 0.112, size = 0, normalized size = 0.

$$\int (c \csc(bx + a))^{4/3} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int((c*csc(b*x+a))^(4/3), x)

[Out] int((c*csc(b*x+a))^(4/3), x)

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int (c \csc(bx + a))^{4/3} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((c*csc(b*x+a))^(4/3),x, algorithm="maxima")

[Out] integrate((c*csc(b*x + a))^(4/3), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\left(c \csc(bx + a)\right)^{\frac{1}{3}} c \csc(bx + a), x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((c*csc(b*x+a))^(4/3),x, algorithm="fricas")

[Out] integral((c*csc(b*x + a))^(1/3)*c*csc(b*x + a), x)

Sympy [F(-1)] time = 0., size = 0, normalized size = 0.

Timed out

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((c*csc(b*x+a))**(4/3),x)

[Out] Timed out

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int (c \csc(bx + a))^{\frac{4}{3}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((c*csc(b*x+a))^(4/3),x, algorithm="giac")

[Out] integrate((c*csc(b*x + a))^(4/3), x)

3.32 $\int (c \csc(a + bx))^{2/3} dx$

Optimal. Leaf size=54

$$\frac{3c \cos(a + bx) \operatorname{Hypergeometric2F1}\left(\frac{1}{6}, \frac{1}{2}, \frac{7}{6}, \sin^2(a + bx)\right)}{b \sqrt{\cos^2(a + bx)} \sqrt[3]{c \csc(a + bx)}}$$

[Out] (3*c*Cos[a + b*x]*Hypergeometric2F1[1/6, 1/2, 7/6, Sin[a + b*x]^2])/(b*Sqrt[Cos[a + b*x]^2]*(c*Csc[a + b*x])^(1/3))

Rubi [A] time = 0.0271586, antiderivative size = 54, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 12, $\frac{\text{number of rules}}{\text{integrand size}} = 0.167$, Rules used = {3772, 2643}

$$\frac{3c \cos(a + bx) {}_2F_1\left(\frac{1}{6}, \frac{1}{2}; \frac{7}{6}; \sin^2(a + bx)\right)}{b \sqrt{\cos^2(a + bx)} \sqrt[3]{c \csc(a + bx)}}$$

Antiderivative was successfully verified.

[In] Int[(c*Csc[a + b*x])^(2/3), x]

[Out] (3*c*Cos[a + b*x]*Hypergeometric2F1[1/6, 1/2, 7/6, Sin[a + b*x]^2])/(b*Sqrt[Cos[a + b*x]^2]*(c*Csc[a + b*x])^(1/3))

Rule 3772

Int[(csc[(c_.) + (d_.)*(x_)])*(b_.)]^(n_), x_Symbol] :> Simp[(b*Csc[c + d*x])^(n - 1)*((Sin[c + d*x]/b)^(n - 1)*Int[1/((Sin[c + d*x]/b)^n, x]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[n]

Rule 2643

Int[((b_.)*sin[(c_.) + (d_.)*(x_)])^(n_), x_Symbol] :> Simp[(Cos[c + d*x]*(b*Sin[c + d*x])^(n + 1)*Hypergeometric2F1[1/2, (n + 1)/2, (n + 3)/2, Sin[c + d*x]^2])/(b*d*(n + 1)*Sqrt[Cos[c + d*x]^2]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[2*n]

Rubi steps

$$\int (c \csc(a + bx))^{2/3} dx = (c \csc(a + bx))^{2/3} \left(\frac{\sin(a + bx)}{c} \right)^{2/3} \int \frac{1}{\left(\frac{\sin(a+bx)}{c} \right)^{2/3}} dx$$

$$= \frac{3 \cos(a + bx)(c \csc(a + bx))^{2/3} {}_2F_1\left(\frac{1}{6}, \frac{1}{2}; \frac{7}{6}; \sin^2(a + bx)\right) \sin(a + bx)}{b\sqrt{\cos^2(a + bx)}}$$

Mathematica [A] time = 0.0684013, size = 59, normalized size = 1.09

$$\frac{\sin(a + bx) \cos(a + bx)(c \csc(a + bx))^{2/3} \text{Hypergeometric2F1}\left(\frac{1}{2}, \frac{5}{6}, \frac{3}{2}, \cos^2(a + bx)\right)}{b^6 \sqrt{\sin^2(a + bx)}}$$

Antiderivative was successfully verified.

[In] Integrate[(c*Csc[a + b*x])^(2/3), x]

[Out] -((Cos[a + b*x]*(c*Csc[a + b*x])^(2/3)*Hypergeometric2F1[1/2, 5/6, 3/2, Cos[a + b*x]^2]*Sin[a + b*x])/(b*(Sin[a + b*x]^2)^(1/6)))

Maple [F] time = 0.146, size = 0, normalized size = 0.

$$\int (c \csc(bx + a))^{2/3} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int((c*csc(b*x+a))^(2/3), x)

[Out] int((c*csc(b*x+a))^(2/3), x)

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int (c \csc(bx + a))^{2/3} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((c*csc(b*x+a))^(2/3),x, algorithm="maxima")

[Out] integrate((c*csc(b*x + a))^(2/3), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left((c \csc (bx + a))^{\frac{2}{3}}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((c*csc(b*x+a))^(2/3),x, algorithm="fricas")

[Out] integral((c*csc(b*x + a))^(2/3), x)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int (c \csc (a + bx))^{\frac{2}{3}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((c*csc(b*x+a))**(2/3),x)

[Out] Integral((c*csc(a + b*x))**(2/3), x)

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int (c \csc (bx + a))^{\frac{2}{3}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((c*csc(b*x+a))^(2/3),x, algorithm="giac")

[Out] integrate((c*csc(b*x + a))^(2/3), x)

3.33 $\int \sqrt[3]{c \csc(a + bx)} dx$

Optimal. Leaf size=56

$$\frac{3c \cos(a + bx) \operatorname{Hypergeometric2F1}\left(\frac{1}{3}, \frac{1}{2}, \frac{4}{3}, \sin^2(a + bx)\right)}{2b \sqrt{\cos^2(a + bx)} (c \csc(a + bx))^{2/3}}$$

[Out] (3*c*Cos[a + b*x]*Hypergeometric2F1[1/3, 1/2, 4/3, Sin[a + b*x]^2])/(2*b*Sqrt[Cos[a + b*x]^2]*(c*Csc[a + b*x])^(2/3))

Rubi [A] time = 0.0263249, antiderivative size = 56, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 12, $\frac{\text{number of rules}}{\text{integrand size}} = 0.167$, Rules used = {3772, 2643}

$$\frac{3c \cos(a + bx) {}_2F_1\left(\frac{1}{3}, \frac{1}{2}; \frac{4}{3}; \sin^2(a + bx)\right)}{2b \sqrt{\cos^2(a + bx)} (c \csc(a + bx))^{2/3}}$$

Antiderivative was successfully verified.

[In] Int[(c*Csc[a + b*x])^(1/3), x]

[Out] (3*c*Cos[a + b*x]*Hypergeometric2F1[1/3, 1/2, 4/3, Sin[a + b*x]^2])/(2*b*Sqrt[Cos[a + b*x]^2]*(c*Csc[a + b*x])^(2/3))

Rule 3772

Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Simp[(b*Csc[c + d*x])^(n - 1)*((Sin[c + d*x]/b)^(n - 1)*Int[1/(Sin[c + d*x]/b)^n, x]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[n]

Rule 2643

Int[((b_.)*sin[(c_.) + (d_.)*(x_)])^(n_), x_Symbol] := Simp[(Cos[c + d*x]*(b*Sin[c + d*x])^(n + 1)*Hypergeometric2F1[1/2, (n + 1)/2, (n + 3)/2, Sin[c + d*x]^2])/(b*d*(n + 1)*Sqrt[Cos[c + d*x]^2]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[2*n]

Rubi steps

$$\int \sqrt[3]{c \csc(a + bx)} dx = \sqrt[3]{c \csc(a + bx)} \sqrt[3]{\frac{\sin(a + bx)}{c}} \int \frac{1}{\sqrt[3]{\frac{\sin(a+bx)}{c}}} dx$$

$$= \frac{3 \cos(a + bx) \sqrt[3]{c \csc(a + bx)} {}_2F_1\left(\frac{1}{3}, \frac{1}{2}; \frac{4}{3}; \sin^2(a + bx)\right) \sin(a + bx)}{2b \sqrt{\cos^2(a + bx)}}$$

Mathematica [A] time = 0.0697324, size = 59, normalized size = 1.05

$$\frac{\sin(a + bx) \cos(a + bx) \sqrt[3]{c \csc(a + bx)} \text{Hypergeometric2F1}\left(\frac{1}{2}, \frac{2}{3}, \frac{3}{2}, \cos^2(a + bx)\right)}{b \sqrt[3]{\sin^2(a + bx)}}$$

Antiderivative was successfully verified.

[In] Integrate[(c*Csc[a + b*x])^(1/3),x]

[Out] -((Cos[a + b*x]*(c*Csc[a + b*x])^(1/3)*Hypergeometric2F1[1/2, 2/3, 3/2, Cos[a + b*x]^2]*Sin[a + b*x])/(b*(Sin[a + b*x]^2)^(1/3)))

Maple [F] time = 0.263, size = 0, normalized size = 0.

$$\int \sqrt[3]{c \csc(bx + a)} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int((c*csc(b*x+a))^(1/3),x)

[Out] int((c*csc(b*x+a))^(1/3),x)

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int (c \csc(bx + a))^{\frac{1}{3}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((c*csc(b*x+a))^(1/3),x, algorithm="maxima")

[Out] integrate((c*csc(b*x + a))^(1/3), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\left(c \csc (bx + a)\right)^{\frac{1}{3}}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((c*csc(b*x+a))^(1/3),x, algorithm="fricas")

[Out] integral((c*csc(b*x + a))^(1/3), x)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \sqrt[3]{c \csc (a + bx)} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((c*csc(b*x+a))**(1/3),x)

[Out] Integral((c*csc(a + b*x))**(1/3), x)

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int (c \csc (bx + a))^{\frac{1}{3}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((c*csc(b*x+a))^(1/3),x, algorithm="giac")

[Out] integrate((c*csc(b*x + a))^(1/3), x)

$$3.34 \quad \int \frac{1}{\sqrt[3]{c \csc(a+bx)}} dx$$

Optimal. Leaf size=56

$$\frac{3c \cos(a+bx) \operatorname{Hypergeometric2F1}\left(\frac{1}{2}, \frac{2}{3}, \frac{5}{3}, \sin^2(a+bx)\right)}{4b \sqrt{\cos^2(a+bx)} (c \csc(a+bx))^{4/3}}$$

[Out] (3*c*cos[a + b*x]*Hypergeometric2F1[1/2, 2/3, 5/3, Sin[a + b*x]^2])/(4*b*Sqrt[Cos[a + b*x]^2]*(c*Csc[a + b*x])^(4/3))

Rubi [A] time = 0.0262917, antiderivative size = 56, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 12, $\frac{\text{number of rules}}{\text{integrand size}} = 0.167$, Rules used = {3772, 2643}

$$\frac{3c \cos(a+bx) {}_2F_1\left(\frac{1}{2}, \frac{2}{3}; \frac{5}{3}; \sin^2(a+bx)\right)}{4b \sqrt{\cos^2(a+bx)} (c \csc(a+bx))^{4/3}}$$

Antiderivative was successfully verified.

[In] Int[(c*Csc[a + b*x])^(-1/3), x]

[Out] (3*c*cos[a + b*x]*Hypergeometric2F1[1/2, 2/3, 5/3, Sin[a + b*x]^2])/(4*b*Sqrt[Cos[a + b*x]^2]*(c*Csc[a + b*x])^(4/3))

Rule 3772

Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Simp[(b*Csc[c + d*x])^(n - 1)*((Sin[c + d*x]/b)^(n - 1)*Int[1/(Sin[c + d*x]/b)^n, x]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[n]

Rule 2643

Int[((b_.)*sin[(c_.) + (d_.)*(x_)])^(n_), x_Symbol] := Simp[(Cos[c + d*x]*(b*Sin[c + d*x])^(n + 1)*Hypergeometric2F1[1/2, (n + 1)/2, (n + 3)/2, Sin[c + d*x]^2])/(b*d*(n + 1)*Sqrt[Cos[c + d*x]^2]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[2*n]

Rubi steps

$$\int \frac{1}{\sqrt[3]{c \csc(a+bx)}} dx = (c \csc(a+bx))^{2/3} \left(\frac{\sin(a+bx)}{c} \right)^{2/3} \int \sqrt[3]{\frac{\sin(a+bx)}{c}} dx$$

$$= \frac{3 \cos(a+bx) (c \csc(a+bx))^{2/3} {}_2F_1\left(\frac{1}{2}, \frac{2}{3}; \frac{5}{3}; \sin^2(a+bx)\right) \sin^2(a+bx)}{4bc \sqrt{\cos^2(a+bx)}}$$

Mathematica [A] time = 0.0661538, size = 59, normalized size = 1.05

$$\frac{\sin(a+bx) \cos(a+bx) \text{Hypergeometric2F1}\left(\frac{1}{3}, \frac{1}{2}, \frac{3}{2}, \cos^2(a+bx)\right)}{b \sin^2(a+bx)^{2/3} \sqrt[3]{c \csc(a+bx)}}$$

Antiderivative was successfully verified.

[In] Integrate[(c*Csc[a + b*x])^(-1/3), x]

[Out] -((Cos[a + b*x]*Hypergeometric2F1[1/3, 1/2, 3/2, Cos[a + b*x]^2]*Sin[a + b*x])/(b*(c*Csc[a + b*x])^(1/3)*(Sin[a + b*x]^2)^(2/3)))

Maple [F] time = 0.142, size = 0, normalized size = 0.

$$\int \frac{1}{\sqrt[3]{c \csc(bx+a)}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(1/(c*csc(b*x+a))^(1/3), x)

[Out] int(1/(c*csc(b*x+a))^(1/3), x)

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(c \csc(bx+a))^{\frac{1}{3}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(c*csc(b*x+a))^(1/3),x, algorithm="maxima")

[Out] integrate((c*csc(b*x + a))^(-1/3), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\frac{(c \csc (bx + a))^{\frac{2}{3}}}{c \csc (bx + a)}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(c*csc(b*x+a))^(1/3),x, algorithm="fricas")

[Out] integral((c*csc(b*x + a))^(2/3)/(c*csc(b*x + a)), x)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\sqrt[3]{c \csc (a + bx)}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(c*csc(b*x+a))**(1/3),x)

[Out] Integral((c*csc(a + b*x))**(-1/3), x)

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(c \csc (bx + a))^{\frac{1}{3}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(c*csc(b*x+a))^(1/3),x, algorithm="giac")

[Out] integrate((c*csc(b*x + a))^(-1/3), x)

$$3.35 \quad \int \frac{1}{(c \csc(a+bx))^{2/3}} dx$$

Optimal. Leaf size=56

$$\frac{3c \cos(a+bx) \operatorname{Hypergeometric2F1}\left(\frac{1}{2}, \frac{5}{6}, \frac{11}{6}, \sin^2(a+bx)\right)}{5b \sqrt{\cos^2(a+bx)} (c \csc(a+bx))^{5/3}}$$

[Out] (3*c*Cos[a + b*x]*Hypergeometric2F1[1/2, 5/6, 11/6, Sin[a + b*x]^2])/(5*b*Sqrt[Cos[a + b*x]^2]*(c*Csc[a + b*x])^(5/3))

Rubi [A] time = 0.0271572, antiderivative size = 56, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 12, $\frac{\text{number of rules}}{\text{integrand size}} = 0.167$, Rules used = {3772, 2643}

$$\frac{3c \cos(a+bx) {}_2F_1\left(\frac{1}{2}, \frac{5}{6}; \frac{11}{6}; \sin^2(a+bx)\right)}{5b \sqrt{\cos^2(a+bx)} (c \csc(a+bx))^{5/3}}$$

Antiderivative was successfully verified.

[In] Int[(c*Csc[a + b*x])^(-2/3), x]

[Out] (3*c*Cos[a + b*x]*Hypergeometric2F1[1/2, 5/6, 11/6, Sin[a + b*x]^2])/(5*b*Sqrt[Cos[a + b*x]^2]*(c*Csc[a + b*x])^(5/3))

Rule 3772

Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^n], x_Symbol] := Simp[(b*Csc[c + d*x])^(n - 1)*((Sin[c + d*x]/b)^(n - 1)*Int[1/(Sin[c + d*x]/b)^n, x]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[n]

Rule 2643

Int[((b_.)*sin[(c_.) + (d_.)*(x_)])^n], x_Symbol] := Simp[(Cos[c + d*x]*(b*Sin[c + d*x])^(n + 1)*Hypergeometric2F1[1/2, (n + 1)/2, (n + 3)/2, Sin[c + d*x]^2])/(b*d*(n + 1)*Sqrt[Cos[c + d*x]^2]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[2*n]

Rubi steps

$$\int \frac{1}{(c \csc(a + bx))^{2/3}} dx = \sqrt[3]{c \csc(a + bx)} \sqrt{\frac{\sin(a + bx)}{c}} \int \left(\frac{\sin(a + bx)}{c} \right)^{2/3} dx$$

$$= \frac{3 \cos(a + bx) \sqrt[3]{c \csc(a + bx)} {}_2F_1\left(\frac{1}{2}, \frac{5}{6}; \frac{11}{6}; \sin^2(a + bx)\right) \sin^2(a + bx)}{5bc \sqrt{\cos^2(a + bx)}}$$

Mathematica [A] time = 0.0642439, size = 59, normalized size = 1.05

$$\frac{\sin(a + bx) \cos(a + bx) \text{Hypergeometric2F1}\left(\frac{1}{6}, \frac{1}{2}, \frac{3}{2}, \cos^2(a + bx)\right)}{b \sin^2(a + bx)^{5/6} (c \csc(a + bx))^{2/3}}$$

Antiderivative was successfully verified.

[In] Integrate[(c*Csc[a + b*x])^(-2/3), x]

[Out] -((Cos[a + b*x]*Hypergeometric2F1[1/6, 1/2, 3/2, Cos[a + b*x]^2]*Sin[a + b*x])/(b*(c*Csc[a + b*x])^(2/3)*(Sin[a + b*x]^2)^(5/6)))

Maple [F] time = 0.288, size = 0, normalized size = 0.

$$\int (c \csc(bx + a))^{-\frac{2}{3}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(1/(c*csc(b*x+a))^(2/3), x)

[Out] int(1/(c*csc(b*x+a))^(2/3), x)

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(c \csc(bx + a))^{\frac{2}{3}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(c*csc(b*x+a))^(2/3),x, algorithm="maxima")

[Out] integrate((c*csc(b*x + a))^(-2/3), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\frac{(c \csc(bx + a))^{\frac{1}{3}}}{c \csc(bx + a)}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(c*csc(b*x+a))^(2/3),x, algorithm="fricas")

[Out] integral((c*csc(b*x + a))^(1/3)/(c*csc(b*x + a)), x)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(c \csc(a + bx))^{\frac{2}{3}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(c*csc(b*x+a))**(2/3),x)

[Out] Integral((c*csc(a + b*x))**(-2/3), x)

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(c \csc(bx + a))^{\frac{2}{3}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(c*csc(b*x+a))^(2/3),x, algorithm="giac")

[Out] integrate((c*csc(b*x + a))^(-2/3), x)

$$3.36 \quad \int \frac{1}{(c \csc(a+bx))^{4/3}} dx$$

Optimal. Leaf size=56

$$\frac{3c \cos(a+bx) \operatorname{Hypergeometric2F1}\left(\frac{1}{2}, \frac{7}{6}, \frac{13}{6}, \sin^2(a+bx)\right)}{7b \sqrt{\cos^2(a+bx)} (c \csc(a+bx))^{7/3}}$$

[Out] (3*c*cos[a + b*x]*Hypergeometric2F1[1/2, 7/6, 13/6, Sin[a + b*x]^2])/(7*b*Sqrt[Cos[a + b*x]^2]*(c*Csc[a + b*x])^(7/3))

Rubi [A] time = 0.0272993, antiderivative size = 56, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 12, $\frac{\text{number of rules}}{\text{integrand size}} = 0.167$, Rules used = {3772, 2643}

$$\frac{3c \cos(a+bx) {}_2F_1\left(\frac{1}{2}, \frac{7}{6}; \frac{13}{6}; \sin^2(a+bx)\right)}{7b \sqrt{\cos^2(a+bx)} (c \csc(a+bx))^{7/3}}$$

Antiderivative was successfully verified.

[In] Int[(c*Csc[a + b*x])^(-4/3), x]

[Out] (3*c*cos[a + b*x]*Hypergeometric2F1[1/2, 7/6, 13/6, Sin[a + b*x]^2])/(7*b*Sqrt[Cos[a + b*x]^2]*(c*Csc[a + b*x])^(7/3))

Rule 3772

Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Simp[(b*Csc[c + d*x])^(n - 1)*((Sin[c + d*x]/b)^(n - 1)*Int[1/(Sin[c + d*x]/b)^n, x]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[n]

Rule 2643

Int[((b_.)*sin[(c_.) + (d_.)*(x_)])^(n_), x_Symbol] := Simp[(Cos[c + d*x]*(b*SIN[c + d*x])^(n + 1)*Hypergeometric2F1[1/2, (n + 1)/2, (n + 3)/2, Sin[c + d*x]^2])/(b*d*(n + 1)*Sqrt[Cos[c + d*x]^2]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[2*n]

Rubi steps

$$\int \frac{1}{(c \csc(a + bx))^{4/3}} dx = (c \csc(a + bx))^{2/3} \left(\frac{\sin(a + bx)}{c} \right)^{2/3} \int \left(\frac{\sin(a + bx)}{c} \right)^{4/3} dx$$

$$= \frac{3 \cos(a + bx) (c \csc(a + bx))^{2/3} {}_2F_1\left(\frac{1}{2}, \frac{7}{6}; \frac{13}{6}; \sin^2(a + bx)\right) \sin^3(a + bx)}{7bc^2 \sqrt{\cos^2(a + bx)}}$$

Mathematica [A] time = 0.155873, size = 76, normalized size = 1.36

$$\frac{\csc^2(a + bx) \left(2 \sin^2(a + bx)^{5/6} \cot(a + bx) \text{Hypergeometric2F1}\left(\frac{1}{2}, \frac{5}{6}, \frac{3}{2}, \cos^2(a + bx)\right) + 3 \sin(2(a + bx)) \right)}{8b(c \csc(a + bx))^{4/3}}$$

Antiderivative was successfully verified.

[In] Integrate[(c*Csc[a + b*x])^(-4/3), x]

[Out] -(Csc[a + b*x]^2*(2*Cot[a + b*x]*Hypergeometric2F1[1/2, 5/6, 3/2, Cos[a + b*x]^2]*(Sin[a + b*x]^2)^(5/6) + 3*Sin[2*(a + b*x)]))/(8*b*(c*Csc[a + b*x])^(4/3))

Maple [F] time = 0.093, size = 0, normalized size = 0.

$$\int (c \csc(bx + a))^{-\frac{4}{3}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(1/(c*csc(b*x+a))^(4/3), x)

[Out] int(1/(c*csc(b*x+a))^(4/3), x)

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(c \csc(bx + a))^{\frac{4}{3}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(c*csc(b*x+a))^(4/3),x, algorithm="maxima")

[Out] integrate((c*csc(b*x + a))^(-4/3), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\frac{(c \csc (bx + a))^{\frac{2}{3}}}{c^2 \csc (bx + a)^2}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(c*csc(b*x+a))^(4/3),x, algorithm="fricas")

[Out] integral((c*csc(b*x + a))^(2/3)/(c^2*csc(b*x + a)^2), x)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(c \csc (a + bx))^{\frac{4}{3}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(c*csc(b*x+a))**(4/3),x)

[Out] Integral((c*csc(a + b*x))**(-4/3), x)

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(c \csc (bx + a))^{\frac{4}{3}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(c*csc(b*x+a))^(4/3),x, algorithm="giac")

[Out] integrate((c*csc(b*x + a))^(-4/3), x)

3.37 $\int \csc^n(a + bx) dx$

Optimal. Leaf size=69

$$\frac{\cos(a + bx) \csc^{n-1}(a + bx) \operatorname{Hypergeometric2F1}\left(\frac{1}{2}, \frac{1-n}{2}, \frac{3-n}{2}, \sin^2(a + bx)\right)}{b(1-n)\sqrt{\cos^2(a + bx)}}$$

[Out] (Cos[a + b*x]*Csc[a + b*x]^(-1 + n)*Hypergeometric2F1[1/2, (1 - n)/2, (3 - n)/2, Sin[a + b*x]^2])/(b*(1 - n)*Sqrt[Cos[a + b*x]^2])

Rubi [A] time = 0.0259089, antiderivative size = 69, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 8, $\frac{\text{number of rules}}{\text{integrand size}} = 0.25$, Rules used = {3772, 2643}

$$\frac{\cos(a + bx) \csc^{n-1}(a + bx) {}_2F_1\left(\frac{1}{2}, \frac{1-n}{2}; \frac{3-n}{2}; \sin^2(a + bx)\right)}{b(1-n)\sqrt{\cos^2(a + bx)}}$$

Antiderivative was successfully verified.

[In] Int[Csc[a + b*x]^n, x]

[Out] (Cos[a + b*x]*Csc[a + b*x]^(-1 + n)*Hypergeometric2F1[1/2, (1 - n)/2, (3 - n)/2, Sin[a + b*x]^2])/(b*(1 - n)*Sqrt[Cos[a + b*x]^2])

Rule 3772

Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Simp[(b*Csc[c + d*x])^(n - 1)*((Sin[c + d*x]/b)^(n - 1)*Int[1/(Sin[c + d*x]/b)^n, x]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[n]

Rule 2643

Int[((b_.)*sin[(c_.) + (d_.)*(x_)])^(n_), x_Symbol] := Simp[(Cos[c + d*x]*(b*SIN[c + d*x])^(n + 1)*Hypergeometric2F1[1/2, (n + 1)/2, (n + 3)/2, Sin[c + d*x]^2])/(b*d*(n + 1)*Sqrt[Cos[c + d*x]^2]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[2*n]

Rubi steps

$$\int \csc^n(a + bx) dx = \csc^n(a + bx) \sin^n(a + bx) \int \sin^{-n}(a + bx) dx$$

$$= \frac{\cos(a + bx) \csc^{-1+n}(a + bx) {}_2F_1\left(\frac{1}{2}, \frac{1-n}{2}; \frac{3-n}{2}; \sin^2(a + bx)\right)}{b(1-n)\sqrt{\cos^2(a + bx)}}$$

Mathematica [A] time = 0.0921054, size = 59, normalized size = 0.86

$$\frac{\cos(a + bx) \sin^2(a + bx)^{\frac{n-1}{2}} \csc^{n-1}(a + bx) \text{Hypergeometric2F1}\left(\frac{1}{2}, \frac{n+1}{2}, \frac{3}{2}, \cos^2(a + bx)\right)}{b}$$

Antiderivative was successfully verified.

[In] Integrate[Csc[a + b*x]^n,x]

[Out] -((Cos[a + b*x]*Csc[a + b*x]^(-1 + n)*Hypergeometric2F1[1/2, (1 + n)/2, 3/2, Cos[a + b*x]^2]*(Sin[a + b*x]^2)^((-1 + n)/2))/b)

Maple [F] time = 0.641, size = 0, normalized size = 0.

$$\int (\csc(bx + a))^n dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(csc(b*x+a)^n,x)

[Out] int(csc(b*x+a)^n,x)

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \csc(bx + a)^n dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^n,x, algorithm="maxima")

[Out] integrate(csc(b*x + a)^n, x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\csc(bx + a)^n, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^n,x, algorithm="fricas")

[Out] integral(csc(b*x + a)^n, x)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \csc^n(a + bx) dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)**n,x)

[Out] Integral(csc(a + b*x)**n, x)

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \csc(bx + a)^n dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(csc(b*x+a)^n,x, algorithm="giac")

[Out] integrate(csc(b*x + a)^n, x)

3.38 $\int (c \csc(a + bx))^n dx$

Optimal. Leaf size=72

$$\frac{c \cos(a + bx)(c \csc(a + bx))^{n-1} \text{Hypergeometric2F1}\left(\frac{1}{2}, \frac{1-n}{2}, \frac{3-n}{2}, \sin^2(a + bx)\right)}{b(1-n)\sqrt{\cos^2(a + bx)}}$$

[Out] (c*Cos[a + b*x]*(c*Csc[a + b*x])^(-1 + n)*Hypergeometric2F1[1/2, (1 - n)/2, (3 - n)/2, Sin[a + b*x]^2])/(b*(1 - n)*Sqrt[Cos[a + b*x]^2])

Rubi [A] time = 0.0297544, antiderivative size = 72, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.2$, Rules used = {3772, 2643}

$$\frac{c \cos(a + bx)(c \csc(a + bx))^{n-1} {}_2F_1\left(\frac{1}{2}, \frac{1-n}{2}; \frac{3-n}{2}; \sin^2(a + bx)\right)}{b(1-n)\sqrt{\cos^2(a + bx)}}$$

Antiderivative was successfully verified.

[In] Int[(c*Csc[a + b*x])^n, x]

[Out] (c*Cos[a + b*x]*(c*Csc[a + b*x])^(-1 + n)*Hypergeometric2F1[1/2, (1 - n)/2, (3 - n)/2, Sin[a + b*x]^2])/(b*(1 - n)*Sqrt[Cos[a + b*x]^2])

Rule 3772

Int[(csc[(c_.) + (d_.)*(x_)])*(b_.)]^(n_), x_Symbol] := Simp[(b*Csc[c + d*x])^(n - 1)*((Sin[c + d*x]/b)^(n - 1)*Int[1/((Sin[c + d*x]/b)^n, x]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[n]

Rule 2643

Int[((b_.)*sin[(c_.) + (d_.)*(x_)])^(n_), x_Symbol] := Simp[(Cos[c + d*x]*(b*Sin[c + d*x])^(n + 1)*Hypergeometric2F1[1/2, (n + 1)/2, (n + 3)/2, Sin[c + d*x]^2])/(b*d*(n + 1)*Sqrt[Cos[c + d*x]^2]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[2*n]

Rubi steps

$$\int (c \csc(a + bx))^n dx = (c \csc(a + bx))^n \left(\frac{\sin(a + bx)}{c} \right)^n \int \left(\frac{\sin(a + bx)}{c} \right)^{-n} dx$$

$$= \frac{\cos(a + bx)(c \csc(a + bx))^n {}_2F_1\left(\frac{1}{2}, \frac{1-n}{2}; \frac{3-n}{2}; \sin^2(a + bx)\right) \sin(a + bx)}{b(1-n)\sqrt{\cos^2(a + bx)}}$$

Mathematica [A] time = 0.0761917, size = 65, normalized size = 0.9

$$\frac{\sin(a + bx) \cos(a + bx) \sin^2(a + bx)^{\frac{n-1}{2}} (c \csc(a + bx))^n \text{Hypergeometric2F1}\left(\frac{1}{2}, \frac{n+1}{2}, \frac{3}{2}, \cos^2(a + bx)\right)}{b}$$

Antiderivative was successfully verified.

[In] Integrate[(c*Csc[a + b*x])^n,x]

[Out] -((Cos[a + b*x]*(c*Csc[a + b*x])^n*Hypergeometric2F1[1/2, (1 + n)/2, 3/2, Cos[a + b*x]^2]*Sin[a + b*x]*(Sin[a + b*x]^2)^((-1 + n)/2))/b)

Maple [F] time = 0.619, size = 0, normalized size = 0.

$$\int (c \csc(bx + a))^n dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int((c*csc(b*x+a))^n,x)

[Out] int((c*csc(b*x+a))^n,x)

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int (c \csc(bx + a))^n dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((c*csc(b*x+a))^n,x, algorithm="maxima")

[Out] integrate((c*csc(b*x + a))^n, x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}((c \csc (bx + a))^n, x)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((c*csc(b*x+a))^n,x, algorithm="fricas")

[Out] integral((c*csc(b*x + a))^n, x)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int (c \csc (a + bx))^n dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((c*csc(b*x+a))**n,x)

[Out] Integral((c*csc(a + b*x))**n, x)

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int (c \csc (bx + a))^n dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((c*csc(b*x+a))^n,x, algorithm="giac")

[Out] integrate((c*csc(b*x + a))^n, x)

3.39 $\int \csc^2(x)^{7/2} dx$

Optimal. Leaf size=50

$$-\frac{1}{6} \cot(x) \csc^2(x)^{5/2} - \frac{5}{24} \cot(x) \csc^2(x)^{3/2} - \frac{5}{16} \cot(x) \sqrt{\csc^2(x)} - \frac{5}{16} \sinh^{-1}(\cot(x))$$

[Out] $(-5*\text{ArcSinh}[\text{Cot}[x]])/16 - (5*\text{Cot}[x]*\text{Sqrt}[\text{Csc}[x]^2])/16 - (5*\text{Cot}[x]*(\text{Csc}[x]^2)^{(3/2)})/24 - (\text{Cot}[x]*(\text{Csc}[x]^2)^{(5/2)})/6$

Rubi [A] time = 0.0168905, antiderivative size = 50, normalized size of antiderivative = 1., number of steps used = 5, number of rules used = 3, integrand size = 8, $\frac{\text{number of rules}}{\text{integrand size}} = 0.375$, Rules used = {4122, 195, 215}

$$-\frac{1}{6} \cot(x) \csc^2(x)^{5/2} - \frac{5}{24} \cot(x) \csc^2(x)^{3/2} - \frac{5}{16} \cot(x) \sqrt{\csc^2(x)} - \frac{5}{16} \sinh^{-1}(\cot(x))$$

Antiderivative was successfully verified.

[In] $\text{Int}[(\text{Csc}[x]^2)^{(7/2)}, x]$

[Out] $(-5*\text{ArcSinh}[\text{Cot}[x]])/16 - (5*\text{Cot}[x]*\text{Sqrt}[\text{Csc}[x]^2])/16 - (5*\text{Cot}[x]*(\text{Csc}[x]^2)^{(3/2)})/24 - (\text{Cot}[x]*(\text{Csc}[x]^2)^{(5/2)})/6$

Rule 4122

$\text{Int}[(b_.)*\text{sec}[(e_.) + (f_.)*(x_.)]^2]^{(p_.)}, x_Symbol] \rightarrow \text{With}[\{ff = \text{FreeFactors}[\text{Tan}[e + f*x], x]\}, \text{Dist}[(b*ff)/f, \text{Subst}[\text{Int}[(b + b*ff^2*x^2)^{(p-1)}, x], x, \text{Tan}[e + f*x]/ff], x]] /; \text{FreeQ}[\{b, e, f, p\}, x] \&\& !\text{IntegerQ}[p]$

Rule 195

$\text{Int}[(a_) + (b_.)*(x_)^{(n_)}]^{(p_.)}, x_Symbol] \rightarrow \text{Simp}[(x*(a + b*x^n)^p)/(n*p + 1), x] + \text{Dist}[(a*n*p)/(n*p + 1), \text{Int}[(a + b*x^n)^{(p-1)}, x], x] /; \text{FreeQ}[\{a, b\}, x] \&\& \text{IGtQ}[n, 0] \&\& \text{GtQ}[p, 0] \&\& (\text{IntegerQ}[2*p] || (\text{EqQ}[n, 2] \&\& \text{IntegerQ}[4*p]) || (\text{EqQ}[n, 2] \&\& \text{IntegerQ}[3*p]) || \text{LtQ}[\text{Denominator}[p + 1/n], \text{Denominator}[p]])$

Rule 215

$\text{Int}[1/\text{Sqrt}[(a_) + (b_.)*(x_)^2], x_Symbol] \rightarrow \text{Simp}[\text{ArcSinh}[(\text{Rt}[b, 2]*x)/\text{Sqrt}[a]]/\text{Rt}[b, 2], x] /; \text{FreeQ}[\{a, b\}, x] \&\& \text{GtQ}[a, 0] \&\& \text{PosQ}[b]$

Rubi steps

$$\begin{aligned}
\int \csc^2(x)^{7/2} dx &= -\text{Subst} \left(\int (1+x^2)^{5/2} dx, x, \cot(x) \right) \\
&= -\frac{1}{6} \cot(x) \csc^2(x)^{5/2} - \frac{5}{6} \text{Subst} \left(\int (1+x^2)^{3/2} dx, x, \cot(x) \right) \\
&= -\frac{5}{24} \cot(x) \csc^2(x)^{3/2} - \frac{1}{6} \cot(x) \csc^2(x)^{5/2} - \frac{5}{8} \text{Subst} \left(\int \sqrt{1+x^2} dx, x, \cot(x) \right) \\
&= -\frac{5}{16} \cot(x) \sqrt{\csc^2(x)} - \frac{5}{24} \cot(x) \csc^2(x)^{3/2} - \frac{1}{6} \cot(x) \csc^2(x)^{5/2} - \frac{5}{16} \text{Subst} \left(\int \frac{1}{\sqrt{1+x^2}} dx, x, \cot(x) \right) \\
&= -\frac{5}{16} \sinh^{-1}(\cot(x)) - \frac{5}{16} \cot(x) \sqrt{\csc^2(x)} - \frac{5}{24} \cot(x) \csc^2(x)^{3/2} - \frac{1}{6} \cot(x) \csc^2(x)^{5/2}
\end{aligned}$$

Mathematica [A] time = 0.257745, size = 92, normalized size = 1.84

$$\frac{1}{384} \sin(x) \sqrt{\csc^2(x)} \left(-\csc^6\left(\frac{x}{2}\right) - 6 \csc^4\left(\frac{x}{2}\right) - 30 \csc^2\left(\frac{x}{2}\right) + \sec^6\left(\frac{x}{2}\right) + 6 \sec^4\left(\frac{x}{2}\right) + 30 \sec^2\left(\frac{x}{2}\right) - 120 \left(\log\left(\cos\left(\frac{x}{2}\right)\right) \right) \right)$$

Antiderivative was successfully verified.

[In] Integrate[(Csc[x]^2)^(7/2), x]

[Out] (Sqrt[Csc[x]^2]*(-30*Csc[x/2]^2 - 6*Csc[x/2]^4 - Csc[x/2]^6 - 120*(Log[Cos[x/2]] - Log[Sin[x/2]])) + 30*Sec[x/2]^2 + 6*Sec[x/2]^4 + Sec[x/2]^6)*Sin[x])/384

Maple [B] time = 0.119, size = 101, normalized size = 2.

$$-\frac{\sqrt{4} \sin(x)}{96} \left(15 (\cos(x))^6 \ln\left(-\frac{-1 + \cos(x)}{\sin(x)}\right) + 15 (\cos(x))^5 - 45 (\cos(x))^4 \ln\left(-\frac{-1 + \cos(x)}{\sin(x)}\right) - 40 (\cos(x))^3 + 45 (\cos(x))^2 \ln\left(-\frac{-1 + \cos(x)}{\sin(x)}\right) + 33 \cos(x) - 15 \ln\left(-\frac{-1 + \cos(x)}{\sin(x)}\right) \right) \sin(x) \left(-1/(\cos(x)^2 - 1) \right)^{7/2}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int((csc(x)^2)^(7/2), x)

[Out] -1/96*4^(1/2)*(15*cos(x)^6*ln(-(-1+cos(x))/sin(x))+15*cos(x)^5-45*cos(x)^4*ln(-(-1+cos(x))/sin(x))-40*cos(x)^3+45*cos(x)^2*ln(-(-1+cos(x))/sin(x))+33*cos(x)-15*ln(-(-1+cos(x))/sin(x)))*sin(x)*(-1/(cos(x)^2-1))^(7/2)

Maxima [B] time = 1.96895, size = 2253, normalized size = 45.06

result too large to display

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((csc(x)^2)^(7/2),x, algorithm="maxima")

[Out]
$$\begin{aligned} & -1/96*(4*(15*\cos(11*x) - 85*\cos(9*x) + 198*\cos(7*x) + 198*\cos(5*x) - 85*\cos(3*x) + 15*\cos(x))*\cos(12*x) - 60*(6*\cos(10*x) - 15*\cos(8*x) + 20*\cos(6*x) \\ & - 15*\cos(4*x) + 6*\cos(2*x) - 1)*\cos(11*x) + 24*(85*\cos(9*x) - 198*\cos(7*x) \\ & - 198*\cos(5*x) + 85*\cos(3*x) - 15*\cos(x))*\cos(10*x) - 340*(15*\cos(8*x) - 20 \\ & *\cos(6*x) + 15*\cos(4*x) - 6*\cos(2*x) + 1)*\cos(9*x) + 60*(198*\cos(7*x) + 198 \\ & *\cos(5*x) - 85*\cos(3*x) + 15*\cos(x))*\cos(8*x) - 792*(20*\cos(6*x) - 15*\cos(4 \\ & *x) + 6*\cos(2*x) - 1)*\cos(7*x) - 80*(198*\cos(5*x) - 85*\cos(3*x) + 15*\cos(x) \\ &)*\cos(6*x) + 792*(15*\cos(4*x) - 6*\cos(2*x) + 1)*\cos(5*x) - 300*(17*\cos(3*x) \\ & - 3*\cos(x))*\cos(4*x) + 340*(6*\cos(2*x) - 1)*\cos(3*x) - 360*\cos(2*x)*\cos(x) \\ & + 15*(2*(6*\cos(10*x) - 15*\cos(8*x) + 20*\cos(6*x) - 15*\cos(4*x) + 6*\cos(2*x) \\ &) - 1)*\cos(12*x) - \cos(12*x)^2 + 12*(15*\cos(8*x) - 20*\cos(6*x) + 15*\cos(4*x) \\ &) - 6*\cos(2*x) + 1)*\cos(10*x) - 36*\cos(10*x)^2 + 30*(20*\cos(6*x) - 15*\cos(4 \\ & *x) + 6*\cos(2*x) - 1)*\cos(8*x) - 225*\cos(8*x)^2 + 40*(15*\cos(4*x) - 6*\cos(2 \\ & *x) + 1)*\cos(6*x) - 400*\cos(6*x)^2 + 30*(6*\cos(2*x) - 1)*\cos(4*x) - 225*\cos \\ & (4*x)^2 - 36*\cos(2*x)^2 + 2*(6*\sin(10*x) - 15*\sin(8*x) + 20*\sin(6*x) - 15*\sin \\ & in(4*x) + 6*\sin(2*x))*\sin(12*x) - \sin(12*x)^2 + 12*(15*\sin(8*x) - 20*\sin(6*x) \\ & x) + 15*\sin(4*x) - 6*\sin(2*x))*\sin(10*x) - 36*\sin(10*x)^2 + 30*(20*\sin(6*x) \\ & - 15*\sin(4*x) + 6*\sin(2*x))*\sin(8*x) - 225*\sin(8*x)^2 + 120*(5*\sin(4*x) - \\ & 2*\sin(2*x))*\sin(6*x) - 400*\sin(6*x)^2 - 225*\sin(4*x)^2 + 180*\sin(4*x)*\sin(2 \\ & *x) - 36*\sin(2*x)^2 + 12*\cos(2*x) - 1)*\log(\cos(x)^2 + \sin(x)^2 + 2*\cos(x) + \\ & 1) - 15*(2*(6*\cos(10*x) - 15*\cos(8*x) + 20*\cos(6*x) - 15*\cos(4*x) + 6*\cos(2*x) \\ & - 1)*\cos(12*x) - \cos(12*x)^2 + 12*(15*\cos(8*x) - 20*\cos(6*x) + 15*\cos(4*x) \\ & - 6*\cos(2*x) + 1)*\cos(10*x) - 36*\cos(10*x)^2 + 30*(20*\cos(6*x) - 15*\cos(4 \\ & *x) + 6*\cos(2*x) - 1)*\cos(8*x) - 225*\cos(8*x)^2 + 40*(15*\cos(4*x) - 6*\cos(2 \\ & *x) + 1)*\cos(6*x) - 400*\cos(6*x)^2 + 30*(6*\cos(2*x) - 1)*\cos(4*x) - 225* \\ & \cos(4*x)^2 - 36*\cos(2*x)^2 + 2*(6*\sin(10*x) - 15*\sin(8*x) + 20*\sin(6*x) - 1 \\ & 5*\sin(4*x) + 6*\sin(2*x))*\sin(12*x) - \sin(12*x)^2 + 12*(15*\sin(8*x) - 20*\sin(6*x) \\ & + 15*\sin(4*x) - 6*\sin(2*x))*\sin(10*x) - 36*\sin(10*x)^2 + 30*(20*\sin(6 \\ & *x) - 15*\sin(4*x) + 6*\sin(2*x))*\sin(8*x) - 225*\sin(8*x)^2 + 120*(5*\sin(4*x) \\ & - 2*\sin(2*x))*\sin(6*x) - 400*\sin(6*x)^2 - 225*\sin(4*x)^2 + 180*\sin(4*x)*\sin(2 \\ & *x) - 36*\sin(2*x)^2 + 12*\cos(2*x) - 1)*\log(\cos(x)^2 + \sin(x)^2 - 2*\cos(x) \\ &) + 1) + 4*(15*\sin(11*x) - 85*\sin(9*x) + 198*\sin(7*x) + 198*\sin(5*x) - 85*\sin(3*x) \\ & + 15*\sin(x))*\sin(12*x) - 60*(6*\sin(10*x) - 15*\sin(8*x) + 20*\sin(6*x) \\ &) - 15*\sin(4*x) + 6*\sin(2*x))*\sin(11*x) + 24*(85*\sin(9*x) - 198*\sin(7*x) - \\ & 198*\sin(5*x) + 85*\sin(3*x) - 15*\sin(x))*\sin(10*x) - 340*(15*\sin(8*x) - 20*s \end{aligned}$$

```

in(6*x) + 15*sin(4*x) - 6*sin(2*x))*sin(9*x) + 60*(198*sin(7*x) + 198*sin(5
*x) - 85*sin(3*x) + 15*sin(x))*sin(8*x) - 792*(20*sin(6*x) - 15*sin(4*x) +
6*sin(2*x))*sin(7*x) - 80*(198*sin(5*x) - 85*sin(3*x) + 15*sin(x))*sin(6*x)
+ 2376*(5*sin(4*x) - 2*sin(2*x))*sin(5*x) - 300*(17*sin(3*x) - 3*sin(x))*s
in(4*x) + 2040*sin(3*x)*sin(2*x) - 360*sin(2*x)*sin(x) + 60*cos(x))/(2*(6*c
os(10*x) - 15*cos(8*x) + 20*cos(6*x) - 15*cos(4*x) + 6*cos(2*x) - 1)*cos(12
*x) - cos(12*x)^2 + 12*(15*cos(8*x) - 20*cos(6*x) + 15*cos(4*x) - 6*cos(2*x
) + 1)*cos(10*x) - 36*cos(10*x)^2 + 30*(20*cos(6*x) - 15*cos(4*x) + 6*cos(2
*x) - 1)*cos(8*x) - 225*cos(8*x)^2 + 40*(15*cos(4*x) - 6*cos(2*x) + 1)*cos(
6*x) - 400*cos(6*x)^2 + 30*(6*cos(2*x) - 1)*cos(4*x) - 225*cos(4*x)^2 - 36*
cos(2*x)^2 + 2*(6*sin(10*x) - 15*sin(8*x) + 20*sin(6*x) - 15*sin(4*x) + 6*s
in(2*x))*sin(12*x) - sin(12*x)^2 + 12*(15*sin(8*x) - 20*sin(6*x) + 15*sin(4
*x) - 6*sin(2*x))*sin(10*x) - 36*sin(10*x)^2 + 30*(20*sin(6*x) - 15*sin(4*x
) + 6*sin(2*x))*sin(8*x) - 225*sin(8*x)^2 + 120*(5*sin(4*x) - 2*sin(2*x))*s
in(6*x) - 400*sin(6*x)^2 - 225*sin(4*x)^2 + 180*sin(4*x)*sin(2*x) - 36*sin(
2*x)^2 + 12*cos(2*x) - 1)

```

Fricas [B] time = 0.486982, size = 302, normalized size = 6.04

$$\frac{30 \cos(x)^5 - 80 \cos(x)^3 - 15 (\cos(x)^6 - 3 \cos(x)^4 + 3 \cos(x)^2 - 1) \log\left(\frac{1}{2} \cos(x) + \frac{1}{2}\right) + 15 (\cos(x)^6 - 3 \cos(x)^4 + 3 \cos(x)^2 - 1) \log\left(-\frac{1}{2} \cos(x) + \frac{1}{2}\right) + 66 \cos(x)}{96 (\cos(x)^6 - 3 \cos(x)^4 + 3 \cos(x)^2 - 1)}$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate((csc(x)^2)^(7/2),x, algorithm="fricas")
```

```
[Out] 1/96*(30*cos(x)^5 - 80*cos(x)^3 - 15*(cos(x)^6 - 3*cos(x)^4 + 3*cos(x)^2 -
1)*log(1/2*cos(x) + 1/2) + 15*(cos(x)^6 - 3*cos(x)^4 + 3*cos(x)^2 - 1)*log(
-1/2*cos(x) + 1/2) + 66*cos(x))/(cos(x)^6 - 3*cos(x)^4 + 3*cos(x)^2 - 1)
```

Sympy [F(-1)] time = 0., size = 0, normalized size = 0.

Timed out

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate((csc(x)**2)**(7/2),x)
```

[Out] Timed out

Giac [B] time = 1.29056, size = 174, normalized size = 3.48

$$\frac{\frac{45(\cos(x)-1)}{\cos(x)+1} - \frac{9(\cos(x)-1)^2}{(\cos(x)+1)^2} + \frac{(\cos(x)-1)^3}{(\cos(x)+1)^3}}{384 \operatorname{sgn}(\sin(x))} - \frac{\left(\frac{9(\cos(x)-1)}{\cos(x)+1} - \frac{45(\cos(x)-1)^2}{(\cos(x)+1)^2} + \frac{110(\cos(x)-1)^3}{(\cos(x)+1)^3} - 1\right)(\cos(x)+1)^3}{384(\cos(x)-1)^3 \operatorname{sgn}(\sin(x))} + \frac{5 \log\left(-\frac{\cos(x)-1}{\cos(x)+1}\right)}{32 \operatorname{sgn}(\sin(x))}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((csc(x)^2)^(7/2),x, algorithm="giac")

[Out] -1/384*(45*(cos(x) - 1)/(cos(x) + 1) - 9*(cos(x) - 1)^2/(cos(x) + 1)^2 + (cos(x) - 1)^3/(cos(x) + 1)^3)/sgn(sin(x)) - 1/384*(9*(cos(x) - 1)/(cos(x) + 1) - 45*(cos(x) - 1)^2/(cos(x) + 1)^2 + 110*(cos(x) - 1)^3/(cos(x) + 1)^3 - 1)*(cos(x) + 1)^3/((cos(x) - 1)^3*sgn(sin(x)))) + 5/32*log(-(cos(x) - 1)/(cos(x) + 1))/sgn(sin(x))

3.40 $\int \csc^2(x)^{5/2} dx$

Optimal. Leaf size=36

$$-\frac{1}{4} \cot(x) \csc^2(x)^{3/2} - \frac{3}{8} \cot(x) \sqrt{\csc^2(x)} - \frac{3}{8} \sinh^{-1}(\cot(x))$$

[Out] $(-3*\text{ArcSinh}[\text{Cot}[x]])/8 - (3*\text{Cot}[x]*\text{Sqrt}[\text{Csc}[x]^2])/8 - (\text{Cot}[x]*(\text{Csc}[x]^2)^{(3/2)})/4$

Rubi [A] time = 0.0123468, antiderivative size = 36, normalized size of antiderivative = 1., number of steps used = 4, number of rules used = 3, integrand size = 8, $\frac{\text{number of rules}}{\text{integrand size}} = 0.375$, Rules used = {4122, 195, 215}

$$-\frac{1}{4} \cot(x) \csc^2(x)^{3/2} - \frac{3}{8} \cot(x) \sqrt{\csc^2(x)} - \frac{3}{8} \sinh^{-1}(\cot(x))$$

Antiderivative was successfully verified.

[In] Int[(Csc[x]^2)^(5/2), x]

[Out] $(-3*\text{ArcSinh}[\text{Cot}[x]])/8 - (3*\text{Cot}[x]*\text{Sqrt}[\text{Csc}[x]^2])/8 - (\text{Cot}[x]*(\text{Csc}[x]^2)^{(3/2)})/4$

Rule 4122

Int[((b_.)*sec[(e_.) + (f_.)*(x_)]^2)^(p_), x_Symbol] :> With[{ff = FreeFactors[Tan[e + f*x], x]}, Dist[(b*ff)/f, Subst[Int[(b + b*ff^2*x^2)^(p - 1), x], x, Tan[e + f*x]/ff], x] /; FreeQ[{b, e, f, p}, x] && !IntegerQ[p]

Rule 195

Int[((a_) + (b_.)*(x_)^(n_))^(p_), x_Symbol] :> Simp[(x*(a + b*x^n)^p)/(n*p + 1), x] + Dist[(a*n*p)/(n*p + 1), Int[(a + b*x^n)^(p - 1), x], x] /; FreeQ[{a, b}, x] && IGtQ[n, 0] && GtQ[p, 0] && (IntegerQ[2*p] || (EqQ[n, 2] && IntegerQ[4*p]) || (EqQ[n, 2] && IntegerQ[3*p]) || LtQ[Denominator[p + 1/n], Denominator[p]])

Rule 215

Int[1/Sqrt[(a_) + (b_.)*(x_)^2], x_Symbol] :> Simp[ArcSinh[(Rt[b, 2]*x)/Sqrt[a]]/Rt[b, 2], x] /; FreeQ[{a, b}, x] && GtQ[a, 0] && PosQ[b]

Rubi steps

$$\begin{aligned}
\int \csc^2(x)^{5/2} dx &= -\text{Subst}\left(\int (1+x^2)^{3/2} dx, x, \cot(x)\right) \\
&= -\frac{1}{4} \cot(x) \csc^2(x)^{3/2} - \frac{3}{4} \text{Subst}\left(\int \sqrt{1+x^2} dx, x, \cot(x)\right) \\
&= -\frac{3}{8} \cot(x) \sqrt{\csc^2(x)} - \frac{1}{4} \cot(x) \csc^2(x)^{3/2} - \frac{3}{8} \text{Subst}\left(\int \frac{1}{\sqrt{1+x^2}} dx, x, \cot(x)\right) \\
&= -\frac{3}{8} \sinh^{-1}(\cot(x)) - \frac{3}{8} \cot(x) \sqrt{\csc^2(x)} - \frac{1}{4} \cot(x) \csc^2(x)^{3/2}
\end{aligned}$$

Mathematica [A] time = 0.243038, size = 72, normalized size = 2.

$$\frac{1}{64} \sin(x) \sqrt{\csc^2(x)} \left(-\csc^4\left(\frac{x}{2}\right) - 6 \csc^2\left(\frac{x}{2}\right) + \sec^4\left(\frac{x}{2}\right) + 6 \sec^2\left(\frac{x}{2}\right) + 24 \left(\log\left(\sin\left(\frac{x}{2}\right)\right) - \log\left(\cos\left(\frac{x}{2}\right)\right) \right) \right)$$

Antiderivative was successfully verified.

[In] Integrate[(Csc[x]^2)^(5/2), x]

[Out] (Sqrt[Csc[x]^2]*(-6*Csc[x/2]^2 - Csc[x/2]^4 + 24*(-Log[Cos[x/2]] + Log[Sin[x/2]]) + 6*Sec[x/2]^2 + Sec[x/2]^4)*Sin[x])/64

Maple [B] time = 0.17, size = 78, normalized size = 2.2

$$\frac{\sqrt{4} \sin(x)}{16} \left(3 (\cos(x))^4 \ln\left(-\frac{-1 + \cos(x)}{\sin(x)}\right) + 3 (\cos(x))^3 - 6 (\cos(x))^2 \ln\left(-\frac{-1 + \cos(x)}{\sin(x)}\right) - 5 \cos(x) + 3 \ln\left(-\frac{-1 + \cos(x)}{\sin(x)}\right) \right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int((csc(x)^2)^(5/2), x)

[Out] 1/16*4^(1/2)*(3*cos(x)^4*ln(-(-1+cos(x))/sin(x))+3*cos(x)^3-6*cos(x)^2*ln(-(-1+cos(x))/sin(x))-5*cos(x)+3*ln(-(-1+cos(x))/sin(x)))*sin(x)*(-1/(cos(x)^2-1))^(5/2)

Maxima [B] time = 1.76746, size = 1173, normalized size = 32.58

result too large to display

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((csc(x)^2)^(5/2),x, algorithm="maxima")

[Out]
$$\begin{aligned} & -1/16*(4*(3*\cos(7*x) - 11*\cos(5*x) - 11*\cos(3*x) + 3*\cos(x))*\cos(8*x) - 12* \\ & (4*\cos(6*x) - 6*\cos(4*x) + 4*\cos(2*x) - 1)*\cos(7*x) + 16*(11*\cos(5*x) + 11* \\ & \cos(3*x) - 3*\cos(x))*\cos(6*x) - 44*(6*\cos(4*x) - 4*\cos(2*x) + 1)*\cos(5*x) - \\ & 24*(11*\cos(3*x) - 3*\cos(x))*\cos(4*x) + 44*(4*\cos(2*x) - 1)*\cos(3*x) - 48*\cos(2*x)*\cos(x) \\ & + 3*(2*(4*\cos(6*x) - 6*\cos(4*x) + 4*\cos(2*x) - 1)*\cos(8*x) - \cos(8*x)^2 + 8*(6*\cos(4*x) - 4*\cos(2*x) + 1)*\cos(6*x) - 16*\cos(6*x)^2 + 12 \\ & *(4*\cos(2*x) - 1)*\cos(4*x) - 36*\cos(4*x)^2 - 16*\cos(2*x)^2 + 4*(2*\sin(6*x) - 3*\sin(4*x) + 2*\sin(2*x))*\sin(8*x) - \sin(8*x)^2 + 16*(3*\sin(4*x) - 2*\sin(2*x))*\sin(6*x) - 16*\sin(6*x)^2 - 36*\sin(4*x)^2 + 48*\sin(4*x)*\sin(2*x) - 16*\sin(2*x)^2 + 8*\cos(2*x) - 1)*\log(\cos(x)^2 + \sin(x)^2 + 2*\cos(x) + 1) - 3*(2*(4*\cos(6*x) - 6*\cos(4*x) + 4*\cos(2*x) - 1)*\cos(8*x) - \cos(8*x)^2 + 8*(6*\cos(4*x) - 4*\cos(2*x) + 1)*\cos(6*x) - 16*\cos(6*x)^2 + 12*(4*\cos(2*x) - 1)*\cos(4*x) - 36*\cos(4*x)^2 - 16*\cos(2*x)^2 + 4*(2*\sin(6*x) - 3*\sin(4*x) + 2*\sin(2*x))*\sin(8*x) - \sin(8*x)^2 + 16*(3*\sin(4*x) - 2*\sin(2*x))*\sin(6*x) - 16*\sin(6*x)^2 - 36*\sin(4*x)^2 + 48*\sin(4*x)*\sin(2*x) - 16*\sin(2*x)^2 + 8*\cos(2*x) - 1)*\log(\cos(x)^2 + \sin(x)^2 - 2*\cos(x) + 1) + 4*(3*\sin(7*x) - 11*\sin(5*x) - 11*\sin(3*x) + 3*\sin(x))*\sin(8*x) - 24*(2*\sin(6*x) - 3*\sin(4*x) + 2*\sin(2*x))*\sin(7*x) + 16*(11*\sin(5*x) + 11*\sin(3*x) - 3*\sin(x))*\sin(6*x) - 88*(3*\sin(4*x) - 2*\sin(2*x))*\sin(5*x) - 24*(11*\sin(3*x) - 3*\sin(x))*\sin(4*x) + 17*6*\sin(3*x)*\sin(2*x) - 48*\sin(2*x)*\sin(x) + 12*\cos(x))/(2*(4*\cos(6*x) - 6*\cos(4*x) + 4*\cos(2*x) - 1)*\cos(8*x) - \cos(8*x)^2 + 8*(6*\cos(4*x) - 4*\cos(2*x) + 1)*\cos(6*x) - 16*\cos(6*x)^2 + 12*(4*\cos(2*x) - 1)*\cos(4*x) - 36*\cos(4*x)^2 - 16*\cos(2*x)^2 + 4*(2*\sin(6*x) - 3*\sin(4*x) + 2*\sin(2*x))*\sin(8*x) - \sin(8*x)^2 + 16*(3*\sin(4*x) - 2*\sin(2*x))*\sin(6*x) - 16*\sin(6*x)^2 - 36*\sin(4*x)^2 + 48*\sin(4*x)*\sin(2*x) - 16*\sin(2*x)^2 + 8*\cos(2*x) - 1) \end{aligned}$$

Fricas [B] time = 0.481315, size = 227, normalized size = 6.31

$$\frac{6 \cos(x)^3 - 3(\cos(x)^4 - 2 \cos(x)^2 + 1) \log\left(\frac{1}{2} \cos(x) + \frac{1}{2}\right) + 3(\cos(x)^4 - 2 \cos(x)^2 + 1) \log\left(-\frac{1}{2} \cos(x) + \frac{1}{2}\right) - 10 \cos(x)}{16(\cos(x)^4 - 2 \cos(x)^2 + 1)}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((csc(x)^2)^(5/2),x, algorithm="fricas")

[Out]
$$\frac{1}{16}*(6*\cos(x)^3 - 3*(\cos(x)^4 - 2*\cos(x)^2 + 1)*\log(1/2*\cos(x) + 1/2) + 3*(\cos(x)^4 - 2*\cos(x)^2 + 1)*\log(-1/2*\cos(x) + 1/2) - 10*\cos(x))/(\cos(x)^4 -$$

$2*\cos(x)^2 + 1)$

Sympy [F(-1)] time = 0., size = 0, normalized size = 0.

Timed out

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((csc(x)**2)**(5/2),x)

[Out] Timed out

Giac [B] time = 1.23869, size = 135, normalized size = 3.75

$$-\frac{(\cos(x) - 1)\operatorname{sgn}(\sin(x))}{8(\cos(x) + 1)} + \frac{(\cos(x) - 1)^2\operatorname{sgn}(\sin(x))}{64(\cos(x) + 1)^2} + \frac{\left(\frac{8(\cos(x)-1)}{\cos(x)+1} - \frac{18(\cos(x)-1)^2}{(\cos(x)+1)^2} - 1\right)(\cos(x) + 1)^2}{64(\cos(x) - 1)^2\operatorname{sgn}(\sin(x))} + \frac{3 \log\left(-\frac{\cos(x)-1}{\cos(x)+1}\right)}{16 \operatorname{sgn}(\sin(x))}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((csc(x)^2)^(5/2),x, algorithm="giac")

[Out] $-1/8*(\cos(x) - 1)*\operatorname{sgn}(\sin(x))/(\cos(x) + 1) + 1/64*(\cos(x) - 1)^2*\operatorname{sgn}(\sin(x)) / (\cos(x) + 1)^2 + 1/64*(8*(\cos(x) - 1)/(\cos(x) + 1) - 18*(\cos(x) - 1)^2/(\cos(x) + 1)^2 - 1)*(\cos(x) + 1)^2/((\cos(x) - 1)^2*\operatorname{sgn}(\sin(x))) + 3/16*\log(-(\cos(x) - 1)/(\cos(x) + 1))/\operatorname{sgn}(\sin(x))$

3.41 $\int \csc^2(x)^{3/2} dx$

Optimal. Leaf size=22

$$-\frac{1}{2} \cot(x) \sqrt{\csc^2(x)} - \frac{1}{2} \sinh^{-1}(\cot(x))$$

[Out] $-\text{ArcSinh}[\text{Cot}[x]]/2 - (\text{Cot}[x] * \text{Sqrt}[\text{Csc}[x]^2])/2$

Rubi [A] time = 0.0094297, antiderivative size = 22, normalized size of antiderivative = 1., number of steps used = 3, number of rules used = 3, integrand size = 8, $\frac{\text{number of rules}}{\text{integrand size}} = 0.375$, Rules used = {4122, 195, 215}

$$-\frac{1}{2} \cot(x) \sqrt{\csc^2(x)} - \frac{1}{2} \sinh^{-1}(\cot(x))$$

Antiderivative was successfully verified.

[In] $\text{Int}[(\text{Csc}[x]^2)^{(3/2)}, x]$

[Out] $-\text{ArcSinh}[\text{Cot}[x]]/2 - (\text{Cot}[x] * \text{Sqrt}[\text{Csc}[x]^2])/2$

Rule 4122

$\text{Int}[(e_{.}) * \sec[(e_{.}) + (f_{.}) * (x_{.})]^2]^{(p_{.})}, x_Symbol] \rightarrow \text{With}[\{ff = \text{FreeFactors}[\text{Tan}[e + f * x], x]\}, \text{Dist}[(b * ff)/f, \text{Subst}[\text{Int}[(b + b * ff^2 * x^2)^{(p - 1)}, x], x, \text{Tan}[e + f * x]/ff], x] /; \text{FreeQ}\{b, e, f, p\}, x\} \&\& \text{!IntegerQ}[p]$

Rule 195

$\text{Int}[(a_{.}) + (b_{.}) * (x_{.})^{(n_{.})}]^{(p_{.})}, x_Symbol] \rightarrow \text{Simp}[(x * (a + b * x^n)^p) / (n * p + 1), x] + \text{Dist}[(a * n * p) / (n * p + 1), \text{Int}[(a + b * x^n)^{(p - 1)}, x], x] /; \text{FreeQ}\{a, b\}, x\} \&\& \text{IGtQ}[n, 0] \&\& \text{GtQ}[p, 0] \&\& (\text{IntegerQ}[2 * p] \parallel (\text{EqQ}[n, 2] \&\& \text{IntegerQ}[4 * p]) \parallel (\text{EqQ}[n, 2] \&\& \text{IntegerQ}[3 * p]) \parallel \text{LtQ}[\text{Denominator}[p + 1/n], \text{Denominator}[p]])$

Rule 215

$\text{Int}[1/\text{Sqrt}[(a_{.}) + (b_{.}) * (x_{.})^2], x_Symbol] \rightarrow \text{Simp}[\text{ArcSinh}[(\text{Rt}[b, 2] * x) / \text{Sqrt}[a]] / \text{Rt}[b, 2], x] /; \text{FreeQ}\{a, b\}, x\} \&\& \text{GtQ}[a, 0] \&\& \text{PosQ}[b]$

Rubi steps

$$\begin{aligned}
\int \csc^2(x)^{3/2} dx &= -\text{Subst} \left(\int \sqrt{1+x^2} dx, x, \cot(x) \right) \\
&= -\frac{1}{2} \cot(x) \sqrt{\csc^2(x)} - \frac{1}{2} \text{Subst} \left(\int \frac{1}{\sqrt{1+x^2}} dx, x, \cot(x) \right) \\
&= -\frac{1}{2} \sinh^{-1}(\cot(x)) - \frac{1}{2} \cot(x) \sqrt{\csc^2(x)}
\end{aligned}$$

Mathematica [B] time = 0.0874973, size = 51, normalized size = 2.32

$$\frac{1}{8} \sin(x) \sqrt{\csc^2(x)} \left(-\csc^2\left(\frac{x}{2}\right) + \sec^2\left(\frac{x}{2}\right) + 4 \log\left(\sin\left(\frac{x}{2}\right)\right) - 4 \log\left(\cos\left(\frac{x}{2}\right)\right) \right)$$

Antiderivative was successfully verified.

[In] Integrate[(Csc[x]^2)^(3/2), x]

[Out] (Sqrt[Csc[x]^2]*(-Csc[x/2]^2 - 4*Log[Cos[x/2]] + 4*Log[Sin[x/2]] + Sec[x/2]^2)*Sin[x])/8

Maple [B] time = 0.086, size = 52, normalized size = 2.4

$$-\frac{\sqrt{4} \sin(x)}{4} \left((\cos(x))^2 \ln\left(-\frac{-1 + \cos(x)}{\sin(x)}\right) + \cos(x) - \ln\left(-\frac{-1 + \cos(x)}{\sin(x)}\right) \right) \left(-((\cos(x))^2 - 1)^{-1} \right)^{\frac{3}{2}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int((csc(x)^2)^(3/2), x)

[Out] -1/4*4^(1/2)*(cos(x)^2*ln(-(-1+cos(x))/sin(x))+cos(x)-ln(-(-1+cos(x))/sin(x)))*sin(x)*(-1/(cos(x)^2-1))^(3/2)

Maxima [B] time = 1.67446, size = 405, normalized size = 18.41

$$4(\cos(3x) + \cos(x)) \cos(4x) - 4(2 \cos(2x) - 1) \cos(3x) - 8 \cos(2x) \cos(x) + (2(2 \cos(2x) - 1) \cos(4x) - \cos(4x))$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((csc(x)^2)^(3/2),x, algorithm="maxima")

[Out]
$$\begin{aligned} & -1/4*(4*(\cos(3*x) + \cos(x))*\cos(4*x) - 4*(2*\cos(2*x) - 1)*\cos(3*x) - 8*\cos(2*x)*\cos(x) + (2*(2*\cos(2*x) - 1)*\cos(4*x) - \cos(4*x)^2 - 4*\cos(2*x)^2 - \sin(4*x)^2 + 4*\sin(4*x)*\sin(2*x) - 4*\sin(2*x)^2 + 4*\cos(2*x) - 1)*\log(\cos(x)^2 + \sin(x)^2 + 2*\cos(x) + 1) - (2*(2*\cos(2*x) - 1)*\cos(4*x) - \cos(4*x)^2 - 4*\cos(2*x)^2 - \sin(4*x)^2 + 4*\sin(4*x)*\sin(2*x) - 4*\sin(2*x)^2 + 4*\cos(2*x) - 1)*\log(\cos(x)^2 + \sin(x)^2 - 2*\cos(x) + 1) + 4*(\sin(3*x) + \sin(x))*\sin(4*x) - 8*\sin(3*x)*\sin(2*x) - 8*\sin(2*x)*\sin(x) + 4*\cos(x))/(2*(2*\cos(2*x) - 1)*\cos(4*x) - \cos(4*x)^2 - 4*\cos(2*x)^2 - \sin(4*x)^2 + 4*\sin(4*x)*\sin(2*x) - 4*\sin(2*x)^2 + 4*\cos(2*x) - 1) \end{aligned}$$

Fricas [B] time = 0.472836, size = 150, normalized size = 6.82

$$\frac{(\cos(x)^2 - 1) \log\left(\frac{1}{2} \cos(x) + \frac{1}{2}\right) - (\cos(x)^2 - 1) \log\left(-\frac{1}{2} \cos(x) + \frac{1}{2}\right) - 2 \cos(x)}{4(\cos(x)^2 - 1)}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((csc(x)^2)^(3/2),x, algorithm="fricas")

[Out]
$$-1/4*((\cos(x)^2 - 1)*\log(1/2*\cos(x) + 1/2) - (\cos(x)^2 - 1)*\log(-1/2*\cos(x) + 1/2) - 2*\cos(x))/(\cos(x)^2 - 1)$$

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int (\csc^2(x))^{\frac{3}{2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((csc(x)**2)**(3/2),x)

[Out] Integral((csc(x)**2)**(3/2), x)

Giac [B] time = 1.30788, size = 93, normalized size = 4.23

$$-\frac{\left(\frac{2(\cos(x)-1)}{\cos(x)+1} - 1\right)(\cos(x) + 1)}{8(\cos(x) - 1)\operatorname{sgn}(\sin(x))} + \frac{\log\left(-\frac{\cos(x)-1}{\cos(x)+1}\right)}{4\operatorname{sgn}(\sin(x))} - \frac{\cos(x) - 1}{8(\cos(x) + 1)\operatorname{sgn}(\sin(x))}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((csc(x)^2)^(3/2),x, algorithm="giac")

[Out] -1/8*(2*(cos(x) - 1)/(cos(x) + 1) - 1)*(cos(x) + 1)/((cos(x) - 1)*sgn(sin(x))) + 1/4*log(-(cos(x) - 1)/(cos(x) + 1))/sgn(sin(x)) - 1/8*(cos(x) - 1)/((cos(x) + 1)*sgn(sin(x)))

3.42 $\int \sqrt{\csc^2(x)} dx$

Optimal. Leaf size=5

$$-\sinh^{-1}(\cot(x))$$

[Out] -ArcSinh[Cot[x]]

Rubi [A] time = 0.0066315, antiderivative size = 5, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 8, $\frac{\text{number of rules}}{\text{integrand size}} = 0.25$, Rules used = {4122, 215}

$$-\sinh^{-1}(\cot(x))$$

Antiderivative was successfully verified.

[In] Int[Sqrt[Csc[x]^2], x]

[Out] -ArcSinh[Cot[x]]

Rule 4122

Int[((b_.)*sec[(e_.) + (f_.)*(x_)^2])^(p_), x_Symbol] :> With[{ff = FreeFactors[Tan[e + f*x], x]}, Dist[(b*ff)/f, Subst[Int[(b + b*ff^2*x^2)^(p - 1), x], x, Tan[e + f*x]/ff], x] /; FreeQ[{b, e, f, p}, x] && !IntegerQ[p]

Rule 215

Int[1/Sqrt[(a_) + (b_.)*(x_)^2], x_Symbol] :> Simp[ArcSinh[(Rt[b, 2]*x)/Sqrt[a]]/Rt[b, 2], x] /; FreeQ[{a, b}, x] && GtQ[a, 0] && PosQ[b]

Rubi steps

$$\begin{aligned} \int \sqrt{\csc^2(x)} dx &= -\text{Subst} \left(\int \frac{1}{\sqrt{1+x^2}} dx, x, \cot(x) \right) \\ &= -\sinh^{-1}(\cot(x)) \end{aligned}$$

Mathematica [B] time = 0.0133144, size = 28, normalized size = 5.6

$$\sin(x)\sqrt{\csc^2(x)}\left(\log\left(\sin\left(\frac{x}{2}\right)\right) - \log\left(\cos\left(\frac{x}{2}\right)\right)\right)$$

Antiderivative was successfully verified.

[In] Integrate[Sqrt[Csc[x]^2],x]

[Out] Sqrt[Csc[x]^2]*(-Log[Cos[x/2]] + Log[Sin[x/2]])*Sin[x]

Maple [B] time = 0.181, size = 31, normalized size = 6.2

$$\frac{\sqrt{4}\sin(x)}{2}\sqrt{-((\cos(x))^2-1)^{-1}\ln\left(\frac{-1+\cos(x)}{\sin(x)}\right)}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int((csc(x)^2)^(1/2),x)

[Out] 1/2*4^(1/2)*sin(x)*(-1/(cos(x)^2-1))^(1/2)*ln(-(-1+cos(x))/sin(x))

Maxima [B] time = 1.64639, size = 47, normalized size = 9.4

$$-\frac{1}{2}\log(\cos(x)^2 + \sin(x)^2 + 2\cos(x) + 1) + \frac{1}{2}\log(\cos(x)^2 + \sin(x)^2 - 2\cos(x) + 1)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((csc(x)^2)^(1/2),x, algorithm="maxima")

[Out] -1/2*log(cos(x)^2 + sin(x)^2 + 2*cos(x) + 1) + 1/2*log(cos(x)^2 + sin(x)^2 - 2*cos(x) + 1)

Fricas [B] time = 0.470925, size = 77, normalized size = 15.4

$$-\frac{1}{2}\log\left(\frac{1}{2}\cos(x) + \frac{1}{2}\right) + \frac{1}{2}\log\left(-\frac{1}{2}\cos(x) + \frac{1}{2}\right)$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate((csc(x)^2)^(1/2),x, algorithm="fricas")
```

```
[Out] -1/2*log(1/2*cos(x) + 1/2) + 1/2*log(-1/2*cos(x) + 1/2)
```

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \sqrt{\csc^2(x)} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate((csc(x)**2)**(1/2),x)
```

```
[Out] Integral(sqrt(csc(x)**2), x)
```

Giac [B] time = 1.24539, size = 16, normalized size = 3.2

$$\frac{\log\left(\left|\tan\left(\frac{1}{2}x\right)\right|\right)}{\operatorname{sgn}(\sin(x))}$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate((csc(x)^2)^(1/2),x, algorithm="giac")
```

```
[Out] log(abs(tan(1/2*x)))/sgn(sin(x))
```

$$3.43 \quad \int \frac{1}{\sqrt{\csc^2(x)}} dx$$

Optimal. Leaf size=12

$$-\frac{\cot(x)}{\sqrt{\csc^2(x)}}$$

[Out] -(Cot[x]/Sqrt[Csc[x]^2])

Rubi [A] time = 0.0093475, antiderivative size = 12, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 8, $\frac{\text{number of rules}}{\text{integrand size}} = 0.25$, Rules used = {4122, 191}

$$-\frac{\cot(x)}{\sqrt{\csc^2(x)}}$$

Antiderivative was successfully verified.

[In] Int[1/Sqrt[Csc[x]^2],x]

[Out] -(Cot[x]/Sqrt[Csc[x]^2])

Rule 4122

```
Int[((b_.)*sec[(e_.) + (f_.)*(x_)]^2)^(p_), x_Symbol] :> With[{ff = FreeFactors[Tan[e + f*x], x]}, Dist[(b*ff)/f, Subst[Int[(b + b*ff^2*x^2)^(p - 1), x], x, Tan[e + f*x]/ff], x]] /; FreeQ[{b, e, f, p}, x] && !IntegerQ[p]
```

Rule 191

```
Int[((a_) + (b_.)*(x_)^(n_))^(p_), x_Symbol] :> Simp[(x*(a + b*x^n)^(p + 1))/a, x] /; FreeQ[{a, b, n, p}, x] && EqQ[1/n + p + 1, 0]
```

Rubi steps

$$\int \frac{1}{\sqrt{\csc^2(x)}} dx = -\text{Subst} \left(\int \frac{1}{(1+x^2)^{3/2}} dx, x, \cot(x) \right)$$

$$= -\frac{\cot(x)}{\sqrt{\csc^2(x)}}$$

Mathematica [A] time = 0.0072935, size = 12, normalized size = 1.

$$-\frac{\cot(x)}{\sqrt{\csc^2(x)}}$$

Antiderivative was successfully verified.

[In] Integrate[1/Sqrt[Csc[x]^2], x]

[Out] -(Cot[x]/Sqrt[Csc[x]^2])

Maple [B] time = 0.127, size = 26, normalized size = 2.2

$$\frac{\sqrt{4} \sin(x)}{-2 + 2 \cos(x)} \frac{1}{\sqrt{-((\cos(x))^2 - 1)^{-1}}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(1/(csc(x)^2)^(1/2), x)

[Out] 1/2*4^(1/2)*sin(x)/(-1/(cos(x)^2-1))^(1/2)/(-1+cos(x))

Maxima [A] time = 1.50187, size = 14, normalized size = 1.17

$$-\frac{1}{\sqrt{\tan(x)^2 + 1}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(csc(x)^2)^(1/2),x, algorithm="maxima")

[Out] -1/sqrt(tan(x)^2 + 1)

Fricas [A] time = 0.463214, size = 12, normalized size = 1.

$$-\cos(x)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(csc(x)^2)^(1/2),x, algorithm="fricas")

[Out] -cos(x)

Sympy [A] time = 0.47557, size = 12, normalized size = 1.

$$-\frac{\cot(x)}{\sqrt{\csc^2(x)}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(csc(x)**2)**(1/2),x)

[Out] -cot(x)/sqrt(csc(x)**2)

Giac [A] time = 1.32864, size = 15, normalized size = 1.25

$$-\cos(x) \operatorname{sgn}(\sin(x)) + \operatorname{sgn}(\sin(x))$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(csc(x)^2)^(1/2),x, algorithm="giac")

[Out] -cos(x)*sgn(sin(x)) + sgn(sin(x))

$$3.44 \quad \int \frac{1}{\csc^2(x)^{3/2}} dx$$

Optimal. Leaf size=29

$$-\frac{2 \cot(x)}{3\sqrt{\csc^2(x)}} - \frac{\cot(x)}{3 \csc^2(x)^{3/2}}$$

[Out] -Cot[x]/(3*(Csc[x]^2)^(3/2)) - (2*Cot[x])/(3*Sqrt[Csc[x]^2])

Rubi [A] time = 0.011221, antiderivative size = 29, normalized size of antiderivative = 1., number of steps used = 3, number of rules used = 3, integrand size = 8, $\frac{\text{number of rules}}{\text{integrand size}} = 0.375$, Rules used = {4122, 192, 191}

$$-\frac{2 \cot(x)}{3\sqrt{\csc^2(x)}} - \frac{\cot(x)}{3 \csc^2(x)^{3/2}}$$

Antiderivative was successfully verified.

[In] Int[(Csc[x]^2)^(-3/2), x]

[Out] -Cot[x]/(3*(Csc[x]^2)^(3/2)) - (2*Cot[x])/(3*Sqrt[Csc[x]^2])

Rule 4122

Int[((b_.)*sec[(e_.) + (f_.)*(x_)]^2)^(p_), x_Symbol] :> With[{ff = FreeFactors[Tan[e + f*x], x]}, Dist[(b*ff)/f, Subst[Int[(b + b*ff^2*x^2)^(p - 1), x], x, Tan[e + f*x]/ff], x] /; FreeQ[{b, e, f, p}, x] && !IntegerQ[p]

Rule 192

Int[((a_) + (b_.)*(x_)^(n_))^(p_), x_Symbol] :> -Simp[(x*(a + b*x^n)^(p + 1))/(a*n*(p + 1)), x] + Dist[(n*(p + 1) + 1)/(a*n*(p + 1)), Int[(a + b*x^n)^(p + 1), x], x] /; FreeQ[{a, b, n, p}, x] && ILtQ[Simplify[1/n + p + 1], 0] && NeQ[p, -1]

Rule 191

Int[((a_) + (b_.)*(x_)^(n_))^(p_), x_Symbol] :> Simp[(x*(a + b*x^n)^(p + 1))/a, x] /; FreeQ[{a, b, n, p}, x] && EqQ[1/n + p + 1, 0]

Rubi steps

$$\begin{aligned} \int \frac{1}{\csc^2(x)^{3/2}} dx &= -\text{Subst} \left(\int \frac{1}{(1+x^2)^{5/2}} dx, x, \cot(x) \right) \\ &= -\frac{\cot(x)}{3 \csc^2(x)^{3/2}} - \frac{2}{3} \text{Subst} \left(\int \frac{1}{(1+x^2)^{3/2}} dx, x, \cot(x) \right) \\ &= -\frac{\cot(x)}{3 \csc^2(x)^{3/2}} - \frac{2 \cot(x)}{3 \sqrt{\csc^2(x)}} \end{aligned}$$

Mathematica [A] time = 0.0165732, size = 23, normalized size = 0.79

$$\frac{(\cos(3x) - 9 \cos(x)) \csc(x)}{12 \sqrt{\csc^2(x)}}$$

Antiderivative was successfully verified.

[In] Integrate[(Csc[x]^2)^(-3/2), x]

[Out] ((-9*Cos[x] + Cos[3*x])*Csc[x])/(12*Sqrt[Csc[x]^2])

Maple [A] time = 0.082, size = 30, normalized size = 1.

$$\frac{\sqrt{4} \sin(x) (\cos(x) - 2)}{6 (-1 + \cos(x))^2} \left(-((\cos(x))^2 - 1)^{-1} \right)^{-\frac{3}{2}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(1/(csc(x)^2)^(3/2), x)

[Out] 1/6*4^(1/2)*sin(x)*(cos(x)-2)/(-1+cos(x))^2/(-1/(cos(x)^2-1))^(3/2)

Maxima [A] time = 1.63545, size = 15, normalized size = 0.52

$$\frac{1}{12} \cos(3x) - \frac{3}{4} \cos(x)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(csc(x)^2)^(3/2),x, algorithm="maxima")`

[Out] $1/12*\cos(3*x) - 3/4*\cos(x)$

Fricas [A] time = 0.46182, size = 31, normalized size = 1.07

$$\frac{1}{3} \cos(x)^3 - \cos(x)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(csc(x)^2)^(3/2),x, algorithm="fricas")`

[Out] $1/3*\cos(x)^3 - \cos(x)$

Sympy [A] time = 1.47768, size = 29, normalized size = 1.

$$-\frac{2 \cot^3(x)}{3 (\csc^2(x))^{\frac{3}{2}}} - \frac{\cot(x)}{(\csc^2(x))^{\frac{3}{2}}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(csc(x)**2)**(3/2),x)`

[Out] $-2*\cot(x)**3/(3*(\csc(x)**2)**(3/2)) - \cot(x)/(\csc(x)**2)**(3/2)$

Giac [B] time = 1.31127, size = 59, normalized size = 2.03

$$-\frac{4 \left(\frac{3(\cos(x)-1)\operatorname{sgn}(\sin(x))}{\cos(x)+1} - \operatorname{sgn}(\sin(x)) \right)}{3 \left(\frac{\cos(x)-1}{\cos(x)+1} - 1 \right)^3} + \frac{4}{3} \operatorname{sgn}(\sin(x))$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/(csc(x)^2)^(3/2),x, algorithm="giac")
```

```
[Out] -4/3*(3*(cos(x) - 1)*sgn(sin(x))/(cos(x) + 1) - sgn(sin(x)))/((cos(x) - 1)/  
(cos(x) + 1) - 1)^3 + 4/3*sgn(sin(x))
```

$$3.45 \quad \int \frac{1}{\csc^2(x)^{5/2}} dx$$

Optimal. Leaf size=43

$$-\frac{8 \cot(x)}{15\sqrt{\csc^2(x)}} - \frac{4 \cot(x)}{15 \csc^2(x)^{3/2}} - \frac{\cot(x)}{5 \csc^2(x)^{5/2}}$$

[Out] $-\text{Cot}[x]/(5*(\text{Csc}[x]^2)^{(5/2)}) - (4*\text{Cot}[x])/(15*(\text{Csc}[x]^2)^{(3/2)}) - (8*\text{Cot}[x])/(15*\text{Sqrt}[\text{Csc}[x]^2])$

Rubi [A] time = 0.0147414, antiderivative size = 43, normalized size of antiderivative = 1., number of steps used = 4, number of rules used = 3, integrand size = 8, $\frac{\text{number of rules}}{\text{integrand size}} = 0.375$, Rules used = {4122, 192, 191}

$$-\frac{8 \cot(x)}{15\sqrt{\csc^2(x)}} - \frac{4 \cot(x)}{15 \csc^2(x)^{3/2}} - \frac{\cot(x)}{5 \csc^2(x)^{5/2}}$$

Antiderivative was successfully verified.

[In] $\text{Int}[(\text{Csc}[x]^2)^{-5/2}, x]$

[Out] $-\text{Cot}[x]/(5*(\text{Csc}[x]^2)^{(5/2)}) - (4*\text{Cot}[x])/(15*(\text{Csc}[x]^2)^{(3/2)}) - (8*\text{Cot}[x])/(15*\text{Sqrt}[\text{Csc}[x]^2])$

Rule 4122

$\text{Int}[(b_*)\text{sec}[(e_*) + (f_*)(x_*)^2]^{(p_*)}, x_Symbol] \rightarrow \text{With}[\{ff = \text{FreeFactors}[\text{Tan}[e + f*x], x]\}, \text{Dist}[(b*ff)/f, \text{Subst}[\text{Int}[(b + b*ff^2*x^2)^{(p - 1)}, x], x, \text{Tan}[e + f*x]/ff], x] /; \text{FreeQ}[\{b, e, f, p\}, x] \&\& \text{!IntegerQ}[p]$

Rule 192

$\text{Int}[(a_*) + (b_*)(x_*)^{(n_*)}]^{(p_*)}, x_Symbol] \rightarrow -\text{Simp}[(x*(a + b*x^n)^{(p + 1)})/(a*n*(p + 1)), x] + \text{Dist}[(n*(p + 1) + 1)/(a*n*(p + 1)), \text{Int}[(a + b*x^n)^{(p + 1)}, x], x] /; \text{FreeQ}[\{a, b, n, p\}, x] \&\& \text{ILtQ}[\text{Simplify}[1/n + p + 1], 0] \&\& \text{NeQ}[p, -1]$

Rule 191

$\text{Int}[(a_*) + (b_*)(x_*)^{(n_*)}]^{(p_*)}, x_Symbol] \rightarrow \text{Simp}[(x*(a + b*x^n)^{(p + 1)})/a, x] /; \text{FreeQ}[\{a, b, n, p\}, x] \&\& \text{EqQ}[1/n + p + 1, 0]$

Rubi steps

$$\begin{aligned}
\int \frac{1}{\csc^2(x)^{5/2}} dx &= -\text{Subst} \left(\int \frac{1}{(1+x^2)^{7/2}} dx, x, \cot(x) \right) \\
&= -\frac{\cot(x)}{5 \csc^2(x)^{5/2}} - \frac{4}{5} \text{Subst} \left(\int \frac{1}{(1+x^2)^{5/2}} dx, x, \cot(x) \right) \\
&= -\frac{\cot(x)}{5 \csc^2(x)^{5/2}} - \frac{4 \cot(x)}{15 \csc^2(x)^{3/2}} - \frac{8}{15} \text{Subst} \left(\int \frac{1}{(1+x^2)^{3/2}} dx, x, \cot(x) \right) \\
&= -\frac{\cot(x)}{5 \csc^2(x)^{5/2}} - \frac{4 \cot(x)}{15 \csc^2(x)^{3/2}} - \frac{8 \cot(x)}{15 \sqrt{\csc^2(x)}}
\end{aligned}$$

Mathematica [A] time = 0.0269639, size = 31, normalized size = 0.72

$$\frac{(150 \cos(x) - 25 \cos(3x) + 3 \cos(5x)) \csc(x)}{240 \sqrt{\csc^2(x)}}$$

Antiderivative was successfully verified.

[In] Integrate[(Csc[x]^2)^(-5/2), x]

[Out] -((150*Cos[x] - 25*Cos[3*x] + 3*Cos[5*x])*Csc[x])/(240*sqrt[Csc[x]^2])

Maple [A] time = 0.077, size = 38, normalized size = 0.9

$$\frac{\sqrt{4} \sin(x) (3 (\cos(x))^2 - 9 \cos(x) + 8)}{30 (-1 + \cos(x))^3} \left(-((\cos(x))^2 - 1)^{-1} \right)^{-\frac{5}{2}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(1/(csc(x)^2)^(5/2), x)

[Out] 1/30*4^(1/2)*sin(x)*(3*cos(x)^2-9*cos(x)+8)/(-1+cos(x))^3/(-1/(cos(x)^2-1))^(5/2)

Maxima [A] time = 1.66542, size = 23, normalized size = 0.53

$$-\frac{1}{80} \cos(5x) + \frac{5}{48} \cos(3x) - \frac{5}{8} \cos(x)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(csc(x)^2)^(5/2),x, algorithm="maxima")

[Out] -1/80*cos(5*x) + 5/48*cos(3*x) - 5/8*cos(x)

Fricas [A] time = 0.471179, size = 53, normalized size = 1.23

$$-\frac{1}{5} \cos(x)^5 + \frac{2}{3} \cos(x)^3 - \cos(x)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(csc(x)^2)^(5/2),x, algorithm="fricas")

[Out] -1/5*cos(x)^5 + 2/3*cos(x)^3 - cos(x)

Sympy [A] time = 19.7235, size = 46, normalized size = 1.07

$$-\frac{8 \cot^5(x)}{15 (\csc^2(x))^{\frac{5}{2}}} - \frac{4 \cot^3(x)}{3 (\csc^2(x))^{\frac{5}{2}}} - \frac{\cot(x)}{(\csc^2(x))^{\frac{5}{2}}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(csc(x)**2)**(5/2),x)

[Out] -8*cot(x)**5/(15*(csc(x)**2)**(5/2)) - 4*cot(x)**3/(3*(csc(x)**2)**(5/2)) - cot(x)/(csc(x)**2)**(5/2)

Giac [A] time = 1.30193, size = 82, normalized size = 1.91

$$-\frac{16 \left(\frac{5(\cos(x)-1)\operatorname{sgn}(\sin(x))}{\cos(x)+1} - \frac{10(\cos(x)-1)^2\operatorname{sgn}(\sin(x))}{(\cos(x)+1)^2} - \operatorname{sgn}(\sin(x)) \right)}{15 \left(\frac{\cos(x)-1}{\cos(x)+1} - 1 \right)^5} + \frac{16}{15} \operatorname{sgn}(\sin(x))$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/(csc(x)^2)^(5/2),x, algorithm="giac")
```

```
[Out] -16/15*(5*(cos(x) - 1)*sgn(sin(x))/(cos(x) + 1) - 10*(cos(x) - 1)^2*sgn(sin(x))/(cos(x) + 1)^2 - sgn(sin(x)))/((cos(x) - 1)/(cos(x) + 1) - 1)^5 + 16/15*sgn(sin(x))
```

$$3.46 \quad \int \frac{1}{\csc^2(x)^{7/2}} dx$$

Optimal. Leaf size=57

$$-\frac{16 \cot(x)}{35\sqrt{\csc^2(x)}} - \frac{8 \cot(x)}{35 \csc^2(x)^{3/2}} - \frac{6 \cot(x)}{35 \csc^2(x)^{5/2}} - \frac{\cot(x)}{7 \csc^2(x)^{7/2}}$$

[Out] $-\text{Cot}[x]/(7*(\text{Csc}[x]^2)^{(7/2)}) - (6*\text{Cot}[x])/(35*(\text{Csc}[x]^2)^{(5/2)}) - (8*\text{Cot}[x])/(35*(\text{Csc}[x]^2)^{(3/2)}) - (16*\text{Cot}[x])/(35*\text{Sqrt}[\text{Csc}[x]^2])$

Rubi [A] time = 0.0188562, antiderivative size = 57, normalized size of antiderivative = 1., number of steps used = 5, number of rules used = 3, integrand size = 8, $\frac{\text{number of rules}}{\text{integrand size}} = 0.375$, Rules used = {4122, 192, 191}

$$-\frac{16 \cot(x)}{35\sqrt{\csc^2(x)}} - \frac{8 \cot(x)}{35 \csc^2(x)^{3/2}} - \frac{6 \cot(x)}{35 \csc^2(x)^{5/2}} - \frac{\cot(x)}{7 \csc^2(x)^{7/2}}$$

Antiderivative was successfully verified.

[In] $\text{Int}[(\text{Csc}[x]^2)^{(-7/2)}, x]$

[Out] $-\text{Cot}[x]/(7*(\text{Csc}[x]^2)^{(7/2)}) - (6*\text{Cot}[x])/(35*(\text{Csc}[x]^2)^{(5/2)}) - (8*\text{Cot}[x])/(35*(\text{Csc}[x]^2)^{(3/2)}) - (16*\text{Cot}[x])/(35*\text{Sqrt}[\text{Csc}[x]^2])$

Rule 4122

$\text{Int}[(b_*)\text{sec}[(e_*) + (f_*)(x_*)^2]^{(p_*)}, x_Symbol] \rightarrow \text{With}[\{\text{ff} = \text{FreeFactors}[\text{Tan}[e + f*x], x]\}, \text{Dist}[(b*\text{ff})/f, \text{Subst}[\text{Int}[(b + b*\text{ff}^2*x^2)^{(p - 1)}, x], x, \text{Tan}[e + f*x]/\text{ff}], x] /; \text{FreeQ}[\{b, e, f, p\}, x] \&\& \text{!IntegerQ}[p]$

Rule 192

$\text{Int}[(a_*) + (b_*)(x_*)^{(n_*)}]^{(p_*)}, x_Symbol] \rightarrow -\text{Simp}[(x*(a + b*x^n)^{(p + 1)})/(a*n*(p + 1)), x] + \text{Dist}[(n*(p + 1) + 1)/(a*n*(p + 1)), \text{Int}[(a + b*x^n)^{(p + 1)}, x], x] /; \text{FreeQ}[\{a, b, n, p\}, x] \&\& \text{ILtQ}[\text{Simplify}[1/n + p + 1], 0] \&\& \text{NeQ}[p, -1]$

Rule 191

$\text{Int}[(a_*) + (b_*)(x_*)^{(n_*)}]^{(p_*)}, x_Symbol] \rightarrow \text{Simp}[(x*(a + b*x^n)^{(p + 1)})/a, x] /; \text{FreeQ}[\{a, b, n, p\}, x] \&\& \text{EqQ}[1/n + p + 1, 0]$

Rubi steps

$$\begin{aligned}
\int \frac{1}{\csc^2(x)^{7/2}} dx &= -\text{Subst} \left(\int \frac{1}{(1+x^2)^{9/2}} dx, x, \cot(x) \right) \\
&= -\frac{\cot(x)}{7 \csc^2(x)^{7/2}} - \frac{6}{7} \text{Subst} \left(\int \frac{1}{(1+x^2)^{7/2}} dx, x, \cot(x) \right) \\
&= -\frac{\cot(x)}{7 \csc^2(x)^{7/2}} - \frac{6 \cot(x)}{35 \csc^2(x)^{5/2}} - \frac{24}{35} \text{Subst} \left(\int \frac{1}{(1+x^2)^{5/2}} dx, x, \cot(x) \right) \\
&= -\frac{\cot(x)}{7 \csc^2(x)^{7/2}} - \frac{6 \cot(x)}{35 \csc^2(x)^{5/2}} - \frac{8 \cot(x)}{35 \csc^2(x)^{3/2}} - \frac{16}{35} \text{Subst} \left(\int \frac{1}{(1+x^2)^{3/2}} dx, x, \cot(x) \right) \\
&= -\frac{\cot(x)}{7 \csc^2(x)^{7/2}} - \frac{6 \cot(x)}{35 \csc^2(x)^{5/2}} - \frac{8 \cot(x)}{35 \csc^2(x)^{3/2}} - \frac{16 \cot(x)}{35 \sqrt{\csc^2(x)}}
\end{aligned}$$

Mathematica [A] time = 0.0409032, size = 37, normalized size = 0.65

$$\frac{(-1225 \cos(x) + 245 \cos(3x) - 49 \cos(5x) + 5 \cos(7x)) \csc(x)}{2240 \sqrt{\csc^2(x)}}$$

Antiderivative was successfully verified.

[In] Integrate[(Csc[x]^2)^(-7/2), x]

[Out] ((-1225*Cos[x] + 245*Cos[3*x] - 49*Cos[5*x] + 5*Cos[7*x])*Csc[x])/(2240*Sqrt[Csc[x]^2])

Maple [A] time = 0.08, size = 44, normalized size = 0.8

$$\frac{\sqrt{4} \sin(x) (5 (\cos(x))^3 - 20 (\cos(x))^2 + 29 \cos(x) - 16)}{70 (-1 + \cos(x))^4} \left(-((\cos(x))^2 - 1)^{-1} \right)^{-\frac{7}{2}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(1/(csc(x)^2)^(7/2), x)

[Out] $\frac{1}{70} 4^{1/2} \sin(x) (5 \cos(x)^3 - 20 \cos(x)^2 + 29 \cos(x) - 16) / (-1 + \cos(x))^4 / (-1 / (\cos(x)^2 - 1))^{7/2}$

Maxima [A] time = 1.63919, size = 31, normalized size = 0.54

$$\frac{1}{448} \cos(7x) - \frac{7}{320} \cos(5x) + \frac{7}{64} \cos(3x) - \frac{35}{64} \cos(x)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(csc(x)^2)^(7/2),x, algorithm="maxima")`

[Out] $1/448 \cos(7*x) - 7/320 \cos(5*x) + 7/64 \cos(3*x) - 35/64 \cos(x)$

Fricas [A] time = 0.472471, size = 66, normalized size = 1.16

$$\frac{1}{7} \cos(x)^7 - \frac{3}{5} \cos(x)^5 + \cos(x)^3 - \cos(x)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(csc(x)^2)^(7/2),x, algorithm="fricas")`

[Out] $1/7 \cos(x)^7 - 3/5 \cos(x)^5 + \cos(x)^3 - \cos(x)$

Sympy [F(-1)] time = 0., size = 0, normalized size = 0.

Timed out

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(csc(x)**2)**(7/2),x)`

[Out] Timed out

Giac [A] time = 1.23918, size = 105, normalized size = 1.84

$$\frac{32 \left(\frac{7(\cos(x)-1)\operatorname{sgn}(\sin(x))}{\cos(x)+1} - \frac{21(\cos(x)-1)^2\operatorname{sgn}(\sin(x))}{(\cos(x)+1)^2} + \frac{35(\cos(x)-1)^3\operatorname{sgn}(\sin(x))}{(\cos(x)+1)^3} - \operatorname{sgn}(\sin(x)) \right)}{35 \left(\frac{\cos(x)-1}{\cos(x)+1} - 1 \right)^7} + \frac{32}{35} \operatorname{sgn}(\sin(x))$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(csc(x)^2)^(7/2),x, algorithm="giac")

[Out] -32/35*(7*(cos(x) - 1)*sgn(sin(x))/(cos(x) + 1) - 21*(cos(x) - 1)^2*sgn(sin(x))/(cos(x) + 1)^2 + 35*(cos(x) - 1)^3*sgn(sin(x))/(cos(x) + 1)^3 - sgn(sin(x)))/((cos(x) - 1)/(cos(x) + 1) - 1)^7 + 32/35*sgn(sin(x))

3.47 $\int (a \csc^2(x))^{7/2} dx$

Optimal. Leaf size=84

$$-\frac{5}{16}a^3 \cot(x)\sqrt{a \csc^2(x)} - \frac{5}{24}a^2 \cot(x) (a \csc^2(x))^{3/2} - \frac{5}{16}a^{7/2} \tanh^{-1}\left(\frac{\sqrt{a} \cot(x)}{\sqrt{a \csc^2(x)}}\right) - \frac{1}{6}a \cot(x) (a \csc^2(x))^{5/2}$$

[Out] $(-5*a^{(7/2)}*ArcTanh[(Sqrt[a]*Cot[x])/Sqrt[a*Csc[x]^2]])/16 - (5*a^3*Cot[x]*Sqrt[a*Csc[x]^2])/16 - (5*a^2*Cot[x]*(a*Csc[x]^2)^{(3/2)})/24 - (a*Cot[x]*(a*Csc[x]^2)^{(5/2)})/6$

Rubi [A] time = 0.0395658, antiderivative size = 84, normalized size of antiderivative = 1., number of steps used = 6, number of rules used = 4, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.4$, Rules used = {4122, 195, 217, 206}

$$-\frac{5}{16}a^3 \cot(x)\sqrt{a \csc^2(x)} - \frac{5}{24}a^2 \cot(x) (a \csc^2(x))^{3/2} - \frac{5}{16}a^{7/2} \tanh^{-1}\left(\frac{\sqrt{a} \cot(x)}{\sqrt{a \csc^2(x)}}\right) - \frac{1}{6}a \cot(x) (a \csc^2(x))^{5/2}$$

Antiderivative was successfully verified.

[In] $\text{Int}[(a*\text{Csc}[x]^2)^{(7/2)}, x]$

[Out] $(-5*a^{(7/2)}*ArcTanh[(Sqrt[a]*Cot[x])/Sqrt[a*Csc[x]^2]])/16 - (5*a^3*Cot[x]*Sqrt[a*Csc[x]^2])/16 - (5*a^2*Cot[x]*(a*Csc[x]^2)^{(3/2)})/24 - (a*Cot[x]*(a*Csc[x]^2)^{(5/2)})/6$

Rule 4122

$\text{Int}[(b_*)*\text{sec}[(e_*) + (f_*)*(x_)]^2)^{(p_*)}, x_Symbol] \rightarrow \text{With}[\{ff = \text{FreeFactors}[\text{Tan}[e + f*x], x]\}, \text{Dist}[(b*ff)/f, \text{Subst}[\text{Int}[(b + b*ff^2*x^2)^{(p - 1)}, x], x, \text{Tan}[e + f*x]/ff], x] /; \text{FreeQ}[\{b, e, f, p\}, x] \ \&\amp; \ !\text{IntegerQ}[p]$

Rule 195

$\text{Int}[(a_*) + (b_*)*(x_)]^{(n_*)})^{(p_*)}, x_Symbol] \rightarrow \text{Simp}[(x*(a + b*x^n)^p)/(n*p + 1), x] + \text{Dist}[(a*n*p)/(n*p + 1), \text{Int}[(a + b*x^n)^{(p - 1)}, x], x] /; \text{FreeQ}[\{a, b\}, x] \ \&\amp; \ \text{IGtQ}[n, 0] \ \&\amp; \ \text{GtQ}[p, 0] \ \&\amp; \ (\text{IntegerQ}[2*p] \ || \ (\text{EqQ}[n, 2] \ \&\amp; \ \text{IntegerQ}[4*p])) \ || \ (\text{EqQ}[n, 2] \ \&\amp; \ \text{IntegerQ}[3*p])) \ || \ \text{LtQ}[\text{Denominator}[p + 1/n], \text{Denominator}[p]]$

Rule 217

Int[1/Sqrt[(a_) + (b_.)*(x_)^2], x_Symbol] := Subst[Int[1/(1 - b*x^2), x], x, x/Sqrt[a + b*x^2]] /; FreeQ[{a, b}, x] && !GtQ[a, 0]

Rule 206

Int[((a_) + (b_.)*(x_)^2)^(-1), x_Symbol] := Simp[(1*ArcTanh[(Rt[-b, 2]*x)/Rt[a, 2]])/(Rt[a, 2]*Rt[-b, 2]), x] /; FreeQ[{a, b}, x] && NegQ[a/b] && (GtQ[a, 0] || LtQ[b, 0])

Rubi steps

$$\begin{aligned}
 \int (a \csc^2(x))^{7/2} dx &= -\left(a \operatorname{Subst}\left(\int (a + ax^2)^{5/2} dx, x, \cot(x)\right)\right) \\
 &= -\frac{1}{6}a \cot(x) (a \csc^2(x))^{5/2} - \frac{1}{6}(5a^2) \operatorname{Subst}\left(\int (a + ax^2)^{3/2} dx, x, \cot(x)\right) \\
 &= -\frac{5}{24}a^2 \cot(x) (a \csc^2(x))^{3/2} - \frac{1}{6}a \cot(x) (a \csc^2(x))^{5/2} - \frac{1}{8}(5a^3) \operatorname{Subst}\left(\int \sqrt{a + ax^2} dx, x, \cot(x)\right) \\
 &= -\frac{5}{16}a^3 \cot(x) \sqrt{a \csc^2(x)} - \frac{5}{24}a^2 \cot(x) (a \csc^2(x))^{3/2} - \frac{1}{6}a \cot(x) (a \csc^2(x))^{5/2} - \frac{1}{16}(5a^4) \operatorname{Subst}\left(\int \sqrt{a + ax^2} dx, x, \cot(x)\right) \\
 &= -\frac{5}{16}a^3 \cot(x) \sqrt{a \csc^2(x)} - \frac{5}{24}a^2 \cot(x) (a \csc^2(x))^{3/2} - \frac{1}{6}a \cot(x) (a \csc^2(x))^{5/2} - \frac{1}{16}(5a^4) \operatorname{Subst}\left(\int \sqrt{a + ax^2} dx, x, \cot(x)\right) \\
 &= -\frac{5}{16}a^{7/2} \tanh^{-1}\left(\frac{\sqrt{a} \cot(x)}{\sqrt{a \csc^2(x)}}\right) - \frac{5}{16}a^3 \cot(x) \sqrt{a \csc^2(x)} - \frac{5}{24}a^2 \cot(x) (a \csc^2(x))^{3/2} - \frac{1}{6}a \cot(x) (a \csc^2(x))^{5/2}
 \end{aligned}$$

Mathematica [A] time = 0.324462, size = 61, normalized size = 0.73

$$\frac{a^3 \csc^5(x) \sqrt{a \csc^2(x)} (-396 \cos(x) + 170 \cos(3x) - 30 \cos(5x) + 480 \sin^6(x) (\log(\sin(\frac{x}{2})) - \log(\cos(\frac{x}{2}))))}{1536}$$

Antiderivative was successfully verified.

[In] Integrate[(a*Csc[x]^2)^(7/2), x]

[Out] (a^3*Csc[x]^5*Sqrt[a*Csc[x]^2]*(-396*Cos[x] + 170*Cos[3*x] - 30*Cos[5*x] + 480*(-Log[Cos[x/2]] + Log[Sin[x/2]])*Sin[x]^6))/1536

Maple [A] time = 0.116, size = 102, normalized size = 1.2

$$-\frac{\sqrt{4} \sin(x)}{96} \left(15 (\cos(x))^6 \ln\left(-\frac{-1 + \cos(x)}{\sin(x)}\right) + 15 (\cos(x))^5 - 45 (\cos(x))^4 \ln\left(-\frac{-1 + \cos(x)}{\sin(x)}\right) - 40 (\cos(x))^3 + 45 (\cos(x))^2 - 15 \cos(x) + 15 \right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `int((a*csc(x)^2)^(7/2),x)`

[Out] $-1/96*4^{(1/2)}*(15*\cos(x)^6*\ln(-(-1+\cos(x))/\sin(x))+15*\cos(x)^5-45*\cos(x)^4*\ln(-(-1+\cos(x))/\sin(x))-40*\cos(x)^3+45*\cos(x)^2*\ln(-(-1+\cos(x))/\sin(x))+33*\cos(x)-15*\ln(-(-1+\cos(x))/\sin(x)))*\sin(x)*(-a/(\cos(x)^2-1))^{(7/2)}$

Maxima [B] time = 14.6467, size = 2947, normalized size = 35.08

result too large to display

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate((a*csc(x)^2)^(7/2),x, algorithm="maxima")`

[Out] $1/48*(1020*a^3*\cos(3*x)*\sin(2*x) - 180*a^3*\cos(x)*\sin(2*x) + 180*a^3*\cos(2*x)*\sin(x) - 30*a^3*\sin(x) + 15*(a^3*\cos(12*x)^2 + 36*a^3*\cos(10*x)^2 + 225*a^3*\cos(8*x)^2 + 400*a^3*\cos(6*x)^2 + 225*a^3*\cos(4*x)^2 + 36*a^3*\cos(2*x)^2 + a^3*\sin(12*x)^2 + 36*a^3*\sin(10*x)^2 + 225*a^3*\sin(8*x)^2 + 400*a^3*\sin(6*x)^2 + 225*a^3*\sin(4*x)^2 - 180*a^3*\sin(4*x)*\sin(2*x) + 36*a^3*\sin(2*x)^2 - 12*a^3*\cos(2*x) + a^3 - 2*(6*a^3*\cos(10*x) - 15*a^3*\cos(8*x) + 20*a^3*\cos(6*x) - 15*a^3*\cos(4*x) + 6*a^3*\cos(2*x) - a^3)*\cos(12*x) - 12*(15*a^3*\cos(8*x) - 20*a^3*\cos(6*x) + 15*a^3*\cos(4*x) - 6*a^3*\cos(2*x) + a^3)*\cos(10*x) - 30*(20*a^3*\cos(6*x) - 15*a^3*\cos(4*x) + 6*a^3*\cos(2*x) - a^3)*\cos(8*x) - 40*(15*a^3*\cos(4*x) - 6*a^3*\cos(2*x) + a^3)*\cos(6*x) - 30*(6*a^3*\cos(2*x) - a^3)*\cos(4*x) - 2*(6*a^3*\sin(10*x) - 15*a^3*\sin(8*x) + 20*a^3*\sin(6*x) - 15*a^3*\sin(4*x) + 6*a^3*\sin(2*x))*\sin(12*x) - 12*(15*a^3*\sin(8*x) - 20*a^3*\sin(6*x) + 15*a^3*\sin(4*x) - 6*a^3*\sin(2*x))*\sin(10*x) - 30*(20*a^3*\sin(6*x) - 15*a^3*\sin(4*x) + 6*a^3*\sin(2*x))*\sin(8*x) - 120*(5*a^3*\sin(4*x) - 2*a^3*\sin(2*x))*\sin(6*x))*\arctan2(\sin(x), \cos(x) + 1) - 15*(a^3*\cos(12*x)^2 + 36*a^3*\cos(10*x)^2 + 225*a^3*\cos(8*x)^2 + 400*a^3*\cos(6*x)^2 + 225*a^3*\cos(4*x)^2 + 36*a^3*\cos(2*x)^2 + a^3*\sin(12*x)^2 + 36*a^3*\sin(10*x)^2 + 225*a^3*\sin(8*x)^2 + 400*a^3*\sin(6*x)^2 + 225*a^3*\sin(4*x)^2 - 180*a^3*\sin(4*x)*\sin(2*x) + 36*a^3*\sin(2*x)^2 - 12*a^3*\cos(2*x) + a^3 - 2*(6*a^3*\cos(10*x) - 15*a^3*\cos(8*x) + 20*a^3*\cos(6*x) - 15*a^3*\cos(4*x) + 6*a^3*\cos(2*x) - a^3)*\cos(12*x) - 12*(15*a^3*\cos(8*x) - 20*a^3*\cos(6*x) + 15*a^3*\cos(4*x) - 6*a^3*\cos(2*x) + a^3)*\cos(10*x) - 30*(20*a^3*\cos(6*x) - 15*a^3*\cos(4*x) + 6*a^3*\cos(2*x) - a^3)*\cos(8*x) - 40*(15*a^3*\cos(4*x) - 6*a^3*\cos(2*x) + a^3)*\cos(6*x) - 30*(6*a^3*\cos(2*x) - a^3)*\cos(4*x) - 2*(6*a^3*\sin(10*x) - 15*a^3*\sin(8*x) + 20*a^3*\sin(6*x) - 15*a^3*\sin(4*x) + 6*a^3*\sin(2*x))*\sin(12*x) - 12*(15*a^3*\sin(8*x) - 20*a^3*\sin(6*x) + 15*a^3*\sin(4*x) - 6*a^3*\sin(2*x))*\sin($

$10*x) - 30*(20*a^3*\sin(6*x) - 15*a^3*\sin(4*x) + 6*a^3*\sin(2*x))*\sin(8*x) -$
 $120*(5*a^3*\sin(4*x) - 2*a^3*\sin(2*x))*\sin(6*x))*\arctan2(\sin(x), \cos(x) - 1)$
 $- 2*(15*a^3*\sin(11*x) - 85*a^3*\sin(9*x) + 198*a^3*\sin(7*x) + 198*a^3*\sin(5$
 $*x) - 85*a^3*\sin(3*x) + 15*a^3*\sin(x))*\cos(12*x) - 30*(6*a^3*\sin(10*x) - 15$
 $*a^3*\sin(8*x) + 20*a^3*\sin(6*x) - 15*a^3*\sin(4*x) + 6*a^3*\sin(2*x))*\cos(11*$
 $x) - 12*(85*a^3*\sin(9*x) - 198*a^3*\sin(7*x) - 198*a^3*\sin(5*x) + 85*a^3*\sin$
 $(3*x) - 15*a^3*\sin(x))*\cos(10*x) - 170*(15*a^3*\sin(8*x) - 20*a^3*\sin(6*x) +$
 $15*a^3*\sin(4*x) - 6*a^3*\sin(2*x))*\cos(9*x) - 30*(198*a^3*\sin(7*x) + 198*a^$
 $3*\sin(5*x) - 85*a^3*\sin(3*x) + 15*a^3*\sin(x))*\cos(8*x) - 396*(20*a^3*\sin(6*$
 $x) - 15*a^3*\sin(4*x) + 6*a^3*\sin(2*x))*\cos(7*x) + 40*(198*a^3*\sin(5*x) - 85$
 $*a^3*\sin(3*x) + 15*a^3*\sin(x))*\cos(6*x) + 1188*(5*a^3*\sin(4*x) - 2*a^3*\sin($
 $2*x))*\cos(5*x) + 150*(17*a^3*\sin(3*x) - 3*a^3*\sin(x))*\cos(4*x) + 2*(15*a^3*$
 $\cos(11*x) - 85*a^3*\cos(9*x) + 198*a^3*\cos(7*x) + 198*a^3*\cos(5*x) - 85*a^3*$
 $\cos(3*x) + 15*a^3*\cos(x))*\sin(12*x) + 30*(6*a^3*\cos(10*x) - 15*a^3*\cos(8*x)$
 $+ 20*a^3*\cos(6*x) - 15*a^3*\cos(4*x) + 6*a^3*\cos(2*x) - a^3)*\sin(11*x) + 12$
 $*(85*a^3*\cos(9*x) - 198*a^3*\cos(7*x) - 198*a^3*\cos(5*x) + 85*a^3*\cos(3*x) -$
 $15*a^3*\cos(x))*\sin(10*x) + 170*(15*a^3*\cos(8*x) - 20*a^3*\cos(6*x) + 15*a^3$
 $*\cos(4*x) - 6*a^3*\cos(2*x) + a^3)*\sin(9*x) + 30*(198*a^3*\cos(7*x) + 198*a^3$
 $*\cos(5*x) - 85*a^3*\cos(3*x) + 15*a^3*\cos(x))*\sin(8*x) + 396*(20*a^3*\cos(6*x$
 $) - 15*a^3*\cos(4*x) + 6*a^3*\cos(2*x) - a^3)*\sin(7*x) - 40*(198*a^3*\cos(5*x)$
 $- 85*a^3*\cos(3*x) + 15*a^3*\cos(x))*\sin(6*x) - 396*(15*a^3*\cos(4*x) - 6*a^3$
 $*\cos(2*x) + a^3)*\sin(5*x) - 150*(17*a^3*\cos(3*x) - 3*a^3*\cos(x))*\sin(4*x) -$
 $170*(6*a^3*\cos(2*x) - a^3)*\sin(3*x))*\sqrt{-a}/(2*(6*\cos(10*x) - 15*\cos(8*x$
 $) + 20*\cos(6*x) - 15*\cos(4*x) + 6*\cos(2*x) - 1)*\cos(12*x) - \cos(12*x)^2 + 1$
 $2*(15*\cos(8*x) - 20*\cos(6*x) + 15*\cos(4*x) - 6*\cos(2*x) + 1)*\cos(10*x) - 36$
 $*\cos(10*x)^2 + 30*(20*\cos(6*x) - 15*\cos(4*x) + 6*\cos(2*x) - 1)*\cos(8*x) - 2$
 $25*\cos(8*x)^2 + 40*(15*\cos(4*x) - 6*\cos(2*x) + 1)*\cos(6*x) - 400*\cos(6*x)^2$
 $+ 30*(6*\cos(2*x) - 1)*\cos(4*x) - 225*\cos(4*x)^2 - 36*\cos(2*x)^2 + 2*(6*\sin$
 $(10*x) - 15*\sin(8*x) + 20*\sin(6*x) - 15*\sin(4*x) + 6*\sin(2*x))*\sin(12*x) -$
 $\sin(12*x)^2 + 12*(15*\sin(8*x) - 20*\sin(6*x) + 15*\sin(4*x) - 6*\sin(2*x))*\sin$
 $(10*x) - 36*\sin(10*x)^2 + 30*(20*\sin(6*x) - 15*\sin(4*x) + 6*\sin(2*x))*\sin(8$
 $*x) - 225*\sin(8*x)^2 + 120*(5*\sin(4*x) - 2*\sin(2*x))*\sin(6*x) - 400*\sin(6*x$
 $)^2 - 225*\sin(4*x)^2 + 180*\sin(4*x)*\sin(2*x) - 36*\sin(2*x)^2 + 12*\cos(2*x)$
 $- 1)$

Fricas [A] time = 0.508105, size = 286, normalized size = 3.4

$$\frac{\left(30 a^3 \cos(x)^5 - 80 a^3 \cos(x)^3 + 66 a^3 \cos(x) + 15 \left(a^3 \cos(x)^6 - 3 a^3 \cos(x)^4 + 3 a^3 \cos(x)^2 - a^3\right) \log\left(-\frac{\cos(x)-1}{\cos(x)+1}\right)\right) \sqrt{-\frac{a}{\cos(x)+1}}}{96 \left(\cos(x)^4 - 2 \cos(x)^2 + 1\right) \sin(x)}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^2)^(7/2),x, algorithm="fricas")

[Out]
$$-1/96*(30*a^3*\cos(x)^5 - 80*a^3*\cos(x)^3 + 66*a^3*\cos(x) + 15*(a^3*\cos(x)^6 - 3*a^3*\cos(x)^4 + 3*a^3*\cos(x)^2 - a^3)*\log(-(\cos(x) - 1)/(\cos(x) + 1)))*\sqrt{-a/(\cos(x)^2 - 1)}/((\cos(x)^4 - 2*\cos(x)^2 + 1)*\sin(x))$$

Sympy [F(-1)] time = 0., size = 0, normalized size = 0.

Timed out

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)**2)**(7/2),x)

[Out] Timed out

Giac [B] time = 1.43107, size = 221, normalized size = 2.63

$$\frac{1}{384} \left(60 a^3 \log\left(-\frac{\cos(x)-1}{\cos(x)+1}\right) \operatorname{sgn}(\sin(x)) - \frac{45 a^3 (\cos(x)-1) \operatorname{sgn}(\sin(x))}{\cos(x)+1} + \frac{9 a^3 (\cos(x)-1)^2 \operatorname{sgn}(\sin(x))}{(\cos(x)+1)^2} - \frac{a^3 (\cos(x)-1)^3 \operatorname{sgn}(\sin(x))}{(\cos(x)+1)^3} \right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^2)^(7/2),x, algorithm="giac")

[Out]
$$\frac{1}{384}*(60*a^3*\log(-(\cos(x) - 1)/(\cos(x) + 1))*\operatorname{sgn}(\sin(x)) - 45*a^3*(\cos(x) - 1)*\operatorname{sgn}(\sin(x))/(\cos(x) + 1) + 9*a^3*(\cos(x) - 1)^2*\operatorname{sgn}(\sin(x))/(\cos(x) + 1)^2 - a^3*(\cos(x) - 1)^3*\operatorname{sgn}(\sin(x))/(\cos(x) + 1)^3 + (a^3*\operatorname{sgn}(\sin(x)) - 9*a^3*(\cos(x) - 1)*\operatorname{sgn}(\sin(x)))/(\cos(x) + 1) + 45*a^3*(\cos(x) - 1)^2*\operatorname{sgn}(\sin(x))/(\cos(x) + 1)^2 - 110*a^3*(\cos(x) - 1)^3*\operatorname{sgn}(\sin(x))/(\cos(x) + 1)^3)*\sqrt{a}/(\cos(x) - 1)^3$$

3.48 $\int \left(a \csc^2(x) \right)^{5/2} dx$

Optimal. Leaf size=65

$$-\frac{3}{8}a^2 \cot(x)\sqrt{a \csc^2(x)} - \frac{3}{8}a^{5/2} \tanh^{-1}\left(\frac{\sqrt{a} \cot(x)}{\sqrt{a \csc^2(x)}}\right) - \frac{1}{4}a \cot(x) \left(a \csc^2(x)\right)^{3/2}$$

[Out] $(-3*a^{(5/2)}*ArcTanh[(Sqrt[a]*Cot[x])/Sqrt[a*Csc[x]^2]])/8 - (3*a^2*Cot[x]*Sqrt[a*Csc[x]^2])/8 - (a*Cot[x]*(a*Csc[x]^2)^{(3/2)})/4$

Rubi [A] time = 0.0291973, antiderivative size = 65, normalized size of antiderivative = 1., number of steps used = 5, number of rules used = 4, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.4$, Rules used = {4122, 195, 217, 206}

$$-\frac{3}{8}a^2 \cot(x)\sqrt{a \csc^2(x)} - \frac{3}{8}a^{5/2} \tanh^{-1}\left(\frac{\sqrt{a} \cot(x)}{\sqrt{a \csc^2(x)}}\right) - \frac{1}{4}a \cot(x) \left(a \csc^2(x)\right)^{3/2}$$

Antiderivative was successfully verified.

[In] Int[(a*Csc[x]^2)^(5/2),x]

[Out] $(-3*a^{(5/2)}*ArcTanh[(Sqrt[a]*Cot[x])/Sqrt[a*Csc[x]^2]])/8 - (3*a^2*Cot[x]*Sqrt[a*Csc[x]^2])/8 - (a*Cot[x]*(a*Csc[x]^2)^{(3/2)})/4$

Rule 4122

Int[((b_.)*sec[(e_.) + (f_.)*(x_)]^2)^(p_), x_Symbol] :> With[{ff = FreeFactors[Tan[e + f*x], x]}, Dist[(b*ff)/f, Subst[Int[(b + b*ff^2*x^2)^(p - 1), x], x, Tan[e + f*x]/ff], x]] /; FreeQ[{b, e, f, p}, x] && !IntegerQ[p]

Rule 195

Int[((a_) + (b_.)*(x_)^(n_))^(p_), x_Symbol] :> Simp[(x*(a + b*x^n)^p)/(n*p + 1), x] + Dist[(a*n*p)/(n*p + 1), Int[(a + b*x^n)^(p - 1), x], x] /; FreeQ[{a, b}, x] && IGtQ[n, 0] && GtQ[p, 0] && (IntegerQ[2*p] || (EqQ[n, 2] && IntegerQ[4*p]) || (EqQ[n, 2] && IntegerQ[3*p]) || LtQ[Denominator[p + 1/n], Denominator[p]])

Rule 217

Int[1/Sqrt[(a_) + (b_)*(x_)^2], x_Symbol] := Subst[Int[1/(1 - b*x^2), x],
x, x/Sqrt[a + b*x^2]] /; FreeQ[{a, b}, x] && !GtQ[a, 0]

Rule 206

Int[((a_) + (b_)*(x_)^2)^(-1), x_Symbol] := Simp[(1*ArcTanh[Rt[-b, 2]*x]/
Rt[a, 2])/(Rt[a, 2]*Rt[-b, 2]), x] /; FreeQ[{a, b}, x] && NegQ[a/b] && (Gt
Q[a, 0] || LtQ[b, 0])

Rubi steps

$$\begin{aligned} \int (a \csc^2(x))^{5/2} dx &= -\left(a \operatorname{Subst}\left(\int (a + ax^2)^{3/2} dx, x, \cot(x)\right)\right) \\ &= -\frac{1}{4}a \cot(x) (a \csc^2(x))^{3/2} - \frac{1}{4}(3a^2) \operatorname{Subst}\left(\int \sqrt{a + ax^2} dx, x, \cot(x)\right) \\ &= -\frac{3}{8}a^2 \cot(x) \sqrt{a \csc^2(x)} - \frac{1}{4}a \cot(x) (a \csc^2(x))^{3/2} - \frac{1}{8}(3a^3) \operatorname{Subst}\left(\int \frac{1}{\sqrt{a + ax^2}} dx, x, \cot(x)\right) \\ &= -\frac{3}{8}a^2 \cot(x) \sqrt{a \csc^2(x)} - \frac{1}{4}a \cot(x) (a \csc^2(x))^{3/2} - \frac{1}{8}(3a^3) \operatorname{Subst}\left(\int \frac{1}{1 - ax^2} dx, x, \frac{\cot(x)}{\sqrt{a \csc^2(x)}}\right) \\ &= -\frac{3}{8}a^{5/2} \tanh^{-1}\left(\frac{\sqrt{a} \cot(x)}{\sqrt{a \csc^2(x)}}\right) - \frac{3}{8}a^2 \cot(x) \sqrt{a \csc^2(x)} - \frac{1}{4}a \cot(x) (a \csc^2(x))^{3/2} \end{aligned}$$

Mathematica [A] time = 0.217325, size = 51, normalized size = 0.78

$$\frac{1}{64} \sin(x) (a \csc^2(x))^{5/2} \left(6 \left(\cos(3x) + 4 \sin^4(x) \left(\log\left(\sin\left(\frac{x}{2}\right)\right) - \log\left(\cos\left(\frac{x}{2}\right)\right)\right)\right) - 22 \cos(x)\right)$$

Antiderivative was successfully verified.

[In] Integrate[(a*Csc[x]^2)^(5/2), x]

[Out] ((a*Csc[x]^2)^(5/2)*Sin[x]*(-22*Cos[x] + 6*(Cos[3*x] + 4*(-Log[Cos[x/2]] + Log[Sin[x/2]])*Sin[x]^4)))/64

Maple [A] time = 0.088, size = 79, normalized size = 1.2

$$\frac{\sqrt{4} \sin(x)}{16} \left(3 (\cos(x))^4 \ln\left(-\frac{-1 + \cos(x)}{\sin(x)}\right) + 3 (\cos(x))^3 - 6 (\cos(x))^2 \ln\left(-\frac{-1 + \cos(x)}{\sin(x)}\right) - 5 \cos(x) + 3 \ln\left(-\frac{-1 + \cos(x)}{\sin(x)}\right)\right)$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] int((a*csc(x)^2)^(5/2),x)
```

```
[Out] 1/16*4^(1/2)*(3*cos(x)^4*ln(-(-1+cos(x))/sin(x))+3*cos(x)^3-6*cos(x)^2*ln(-(-1+cos(x))/sin(x))-5*cos(x)+3*ln(-(-1+cos(x))/sin(x)))*sin(x)*(-a/(cos(x)^2-1))^(5/2)
```

Maxima [B] time = 2.6638, size = 1503, normalized size = 23.12

result too large to display

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate((a*csc(x)^2)^(5/2),x, algorithm="maxima")
```

```
[Out] 1/8*(88*a^2*cos(3*x)*sin(2*x) - 24*a^2*cos(x)*sin(2*x) + 24*a^2*cos(2*x)*sin(x) - 6*a^2*sin(x) + 3*(a^2*cos(8*x)^2 + 16*a^2*cos(6*x)^2 + 36*a^2*cos(4*x)^2 + 16*a^2*cos(2*x)^2 + a^2*sin(8*x)^2 + 16*a^2*sin(6*x)^2 + 36*a^2*sin(4*x)^2 - 48*a^2*sin(4*x)*sin(2*x) + 16*a^2*sin(2*x)^2 - 8*a^2*cos(2*x) + a^2 - 2*(4*a^2*cos(6*x) - 6*a^2*cos(4*x) + 4*a^2*cos(2*x) - a^2)*cos(8*x) - 8*(6*a^2*cos(4*x) - 4*a^2*cos(2*x) + a^2)*cos(6*x) - 12*(4*a^2*cos(2*x) - a^2)*cos(4*x) - 4*(2*a^2*sin(6*x) - 3*a^2*sin(4*x) + 2*a^2*sin(2*x))*sin(8*x) - 16*(3*a^2*sin(4*x) - 2*a^2*sin(2*x))*sin(6*x))*arctan2(sin(x), cos(x) + 1) - 3*(a^2*cos(8*x)^2 + 16*a^2*cos(6*x)^2 + 36*a^2*cos(4*x)^2 + 16*a^2*cos(2*x)^2 + a^2*sin(8*x)^2 + 16*a^2*sin(6*x)^2 + 36*a^2*sin(4*x)^2 - 48*a^2*sin(4*x)*sin(2*x) + 16*a^2*sin(2*x)^2 - 8*a^2*cos(2*x) + a^2 - 2*(4*a^2*cos(6*x) - 6*a^2*cos(4*x) + 4*a^2*cos(2*x) - a^2)*cos(8*x) - 8*(6*a^2*cos(4*x) - 4*a^2*cos(2*x) + a^2)*cos(6*x) - 12*(4*a^2*cos(2*x) - a^2)*cos(4*x) - 4*(2*a^2*sin(6*x) - 3*a^2*sin(4*x) + 2*a^2*sin(2*x))*sin(8*x) - 16*(3*a^2*sin(4*x) - 2*a^2*sin(2*x))*sin(6*x))*arctan2(sin(x), cos(x) - 1) - 2*(3*a^2*sin(7*x) - 11*a^2*sin(5*x) - 11*a^2*sin(3*x) + 3*a^2*sin(x))*cos(8*x) - 12*(2*a^2*sin(6*x) - 3*a^2*sin(4*x) + 2*a^2*sin(2*x))*cos(7*x) - 8*(11*a^2*sin(5*x) + 11*a^2*sin(3*x) - 3*a^2*sin(x))*cos(6*x) - 44*(3*a^2*sin(4*x) - 2*a^2*sin(2*x))*cos(5*x) + 12*(11*a^2*sin(3*x) - 3*a^2*sin(x))*cos(4*x) + 2*(3*a^2*cos(7*x) - 11*a^2*cos(5*x) - 11*a^2*cos(3*x) + 3*a^2*cos(x))*sin(8*x) + 6*(4*a^2*cos(6*x) - 6*a^2*cos(4*x) + 4*a^2*cos(2*x) - a^2)*sin(7*x) + 8*(11*a^2*cos(5*x) + 11*a^2*cos(3*x) - 3*a^2*cos(x))*sin(6*x) + 22*(6*a^2*cos(4*x) - 4*a^2*cos(2*x) + a^2)*sin(5*x) - 12*(11*a^2*cos(3*x) - 3*a^2*cos(x))*sin(4*x) - 22*(4*a^2*cos(2*x) - a^2)*sin(3*x))*sqrt(-a)/(2*(4*cos(6*x) - 6*cos(4*x) + 4*cos(2*x) - 1)*cos(8*x) - cos(8*x)^2 + 8*(6*cos(4*x) - 4*cos(2*x) + 1)*cos(6*x) - 16*cos(6*x)^2 + 12*(4*cos(2*x) - 1)*cos(4*x) - 36*cos(4*x)
```

$$\begin{aligned} &^2 - 16\cos(2x)^2 + 4(2\sin(6x) - 3\sin(4x) + 2\sin(2x))\sin(8x) - \sin(8x)^2 \\ &+ 16(3\sin(4x) - 2\sin(2x))\sin(6x) - 16\sin(6x)^2 - 36\sin(4x)^2 \\ &+ 48\sin(4x)\sin(2x) - 16\sin(2x)^2 + 8\cos(2x) - 1 \end{aligned}$$

Fricas [A] time = 0.495597, size = 219, normalized size = 3.37

$$\frac{\left(6a^2\cos(x)^3 - 10a^2\cos(x) + 3(a^2\cos(x)^4 - 2a^2\cos(x)^2 + a^2)\log\left(-\frac{\cos(x)-1}{\cos(x)+1}\right)\right)\sqrt{-\frac{a}{\cos(x)^2-1}}}{16(\cos(x)^2-1)\sin(x)}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^2)^(5/2),x, algorithm="fricas")

[Out] $-1/16*(6*a^2*\cos(x)^3 - 10*a^2*\cos(x) + 3*(a^2*\cos(x)^4 - 2*a^2*\cos(x)^2 + a^2)*\log(-(\cos(x) - 1)/(\cos(x) + 1)))*\sqrt{-a/(\cos(x)^2 - 1)}/((\cos(x)^2 - 1)*\sin(x))$

Sympy [F(-1)] time = 0., size = 0, normalized size = 0.

Timed out

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)**2)**(5/2),x)

[Out] Timed out

Giac [B] time = 1.28591, size = 167, normalized size = 2.57

$$\frac{1}{64}\left(12a^2\log\left(-\frac{\cos(x)-1}{\cos(x)+1}\right)\operatorname{sgn}(\sin(x)) - \frac{8a^2(\cos(x)-1)\operatorname{sgn}(\sin(x))}{\cos(x)+1} + \frac{a^2(\cos(x)-1)^2\operatorname{sgn}(\sin(x))}{(\cos(x)+1)^2} - \frac{a^2\operatorname{sgn}(\sin(x))}{\cos(x)+1}\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^2)^(5/2),x, algorithm="giac")

```
[Out] 1/64*(12*a^2*log(-(cos(x) - 1)/(cos(x) + 1))*sgn(sin(x)) - 8*a^2*(cos(x) - 1)*sgn(sin(x))/(cos(x) + 1) + a^2*(cos(x) - 1)^2*sgn(sin(x))/(cos(x) + 1)^2 - (a^2*sgn(sin(x)) - 8*a^2*(cos(x) - 1)*sgn(sin(x))/(cos(x) + 1) + 18*a^2*(cos(x) - 1)^2*sgn(sin(x))/(cos(x) + 1)^2)*(cos(x) + 1)^2/(cos(x) - 1)^2)*sqrt(a)
```

3.49 $\int (a \csc^2(x))^{3/2} dx$

Optimal. Leaf size=46

$$-\frac{1}{2}a^{3/2} \tanh^{-1}\left(\frac{\sqrt{a} \cot(x)}{\sqrt{a \csc^2(x)}}\right) - \frac{1}{2}a \cot(x) \sqrt{a \csc^2(x)}$$

[Out] $-(a^{(3/2)} * \text{ArcTanh}[(\text{Sqrt}[a] * \text{Cot}[x]) / \text{Sqrt}[a * \text{Csc}[x]^2]]) / 2 - (a * \text{Cot}[x] * \text{Sqrt}[a * \text{Csc}[x]^2]) / 2$

Rubi [A] time = 0.0219625, antiderivative size = 46, normalized size of antiderivative = 1., number of steps used = 4, number of rules used = 4, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.4$, Rules used = {4122, 195, 217, 206}

$$-\frac{1}{2}a^{3/2} \tanh^{-1}\left(\frac{\sqrt{a} \cot(x)}{\sqrt{a \csc^2(x)}}\right) - \frac{1}{2}a \cot(x) \sqrt{a \csc^2(x)}$$

Antiderivative was successfully verified.

[In] $\text{Int}[(a * \text{Csc}[x]^2)^{(3/2)}, x]$

[Out] $-(a^{(3/2)} * \text{ArcTanh}[(\text{Sqrt}[a] * \text{Cot}[x]) / \text{Sqrt}[a * \text{Csc}[x]^2]]) / 2 - (a * \text{Cot}[x] * \text{Sqrt}[a * \text{Csc}[x]^2]) / 2$

Rule 4122

$\text{Int}[(b * \sec(e + f * x) + (f * x)^2)^p, x_Symbol] \rightarrow \text{With}[\{ff = \text{FreeFactors}[\text{Tan}[e + f * x], x]\}, \text{Dist}[(b * ff) / f, \text{Subst}[\text{Int}[(b + b * ff^2 * x^2)^{p - 1}, x], x, \text{Tan}[e + f * x] / ff], x] /; \text{FreeQ}[\{b, e, f, p\}, x] \&\& \text{!IntegerQ}[p]$

Rule 195

$\text{Int}[(a + (b * x)^n)^p, x_Symbol] \rightarrow \text{Simp}[(x * (a + b * x^n)^p) / (n * p + 1), x] + \text{Dist}[(a * n * p) / (n * p + 1), \text{Int}[(a + b * x^n)^{p - 1}, x], x] /; \text{FreeQ}[\{a, b\}, x] \&\& \text{IGtQ}[n, 0] \&\& \text{GtQ}[p, 0] \&\& (\text{IntegerQ}[2 * p] \parallel (\text{EqQ}[n, 2] \&\& \text{IntegerQ}[4 * p]) \parallel (\text{EqQ}[n, 2] \&\& \text{IntegerQ}[3 * p]) \parallel \text{LtQ}[\text{Denominator}[p + 1/n], \text{Denominator}[p]])$

Rule 217

```
Int[1/Sqrt[(a_) + (b_.)*(x_)^2], x_Symbol] := Subst[Int[1/(1 - b*x^2), x],
x, x/Sqrt[a + b*x^2]] /; FreeQ[{a, b}, x] && !GtQ[a, 0]
```

Rule 206

```
Int[((a_) + (b_.)*(x_)^2)^(-1), x_Symbol] := Simp[(1*ArcTanh[(Rt[-b, 2]*x)/
Rt[a, 2]])/(Rt[a, 2]*Rt[-b, 2]), x] /; FreeQ[{a, b}, x] && NegQ[a/b] && (Gt
Q[a, 0] || LtQ[b, 0])
```

Rubi steps

$$\begin{aligned} \int (a \csc^2(x))^{3/2} dx &= -\left(a \operatorname{Subst}\left(\int \sqrt{a + ax^2} dx, x, \cot(x)\right)\right) \\ &= -\frac{1}{2}a \cot(x) \sqrt{a \csc^2(x)} - \frac{1}{2}a^2 \operatorname{Subst}\left(\int \frac{1}{\sqrt{a + ax^2}} dx, x, \cot(x)\right) \\ &= -\frac{1}{2}a \cot(x) \sqrt{a \csc^2(x)} - \frac{1}{2}a^2 \operatorname{Subst}\left(\int \frac{1}{1 - ax^2} dx, x, \frac{\cot(x)}{\sqrt{a \csc^2(x)}}\right) \\ &= -\frac{1}{2}a^{3/2} \tanh^{-1}\left(\frac{\sqrt{a} \cot(x)}{\sqrt{a \csc^2(x)}}\right) - \frac{1}{2}a \cot(x) \sqrt{a \csc^2(x)} \end{aligned}$$

Mathematica [A] time = 0.0719564, size = 39, normalized size = 0.85

$$-\frac{1}{2}a \sin(x) \sqrt{a \csc^2(x)} \left(-\log\left(\sin\left(\frac{x}{2}\right)\right) + \log\left(\cos\left(\frac{x}{2}\right)\right) + \cot(x) \csc(x)\right)$$

Antiderivative was successfully verified.

```
[In] Integrate[(a*Csc[x]^2)^(3/2), x]
```

```
[Out] -(a*Sqrt[a*Csc[x]^2]*(Cot[x]*Csc[x] + Log[Cos[x/2]] - Log[Sin[x/2]])*Sin[x]
)/2
```

Maple [A] time = 0.078, size = 53, normalized size = 1.2

$$-\frac{\sqrt{4} \sin(x)}{4} \left((\cos(x))^2 \ln\left(-\frac{-1 + \cos(x)}{\sin(x)}\right) + \cos(x) - \ln\left(-\frac{-1 + \cos(x)}{\sin(x)}\right) \right) \left(-\frac{a}{(\cos(x))^2 - 1}\right)^{\frac{3}{2}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int((a*csc(x)^2)^(3/2),x)

[Out] $-1/4*4^{(1/2)}*(\cos(x)^2*\ln(-(-1+\cos(x))/\sin(x))+\cos(x)-\ln(-(-1+\cos(x))/\sin(x))) * \sin(x) * (-a/(\cos(x)^2-1))^{(3/2)}$

Maxima [B] time = 1.69075, size = 429, normalized size = 9.33

$(4a \cos(3x) \sin(2x) + 4a \cos(x) \sin(2x) - 4a \cos(2x) \sin(x) - (a \cos(4x)^2 + 4a \cos(2x)^2 + a \sin(4x)^2 - 4a \sin$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^2)^(3/2),x, algorithm="maxima")

[Out] $-1/2*(4*a*\cos(3*x)*\sin(2*x) + 4*a*\cos(x)*\sin(2*x) - 4*a*\cos(2*x)*\sin(x) - (a*\cos(4*x)^2 + 4*a*\cos(2*x)^2 + a*\sin(4*x)^2 - 4*a*\sin(4*x)*\sin(2*x) + 4*a*\sin(2*x)^2 - 2*(2*a*\cos(2*x) - a)*\cos(4*x) - 4*a*\cos(2*x) + a)*\arctan2(\sin(x), \cos(x) + 1) + (a*\cos(4*x)^2 + 4*a*\cos(2*x)^2 + a*\sin(4*x)^2 - 4*a*\sin(4*x)*\sin(2*x) + 4*a*\sin(2*x)^2 - 2*(2*a*\cos(2*x) - a)*\cos(4*x) - 4*a*\cos(2*x) + a)*\arctan2(\sin(x), \cos(x) - 1) + 2*(a*\sin(3*x) + a*\sin(x))*\cos(4*x) - 2*(a*\cos(3*x) + a*\cos(x))*\sin(4*x) - 2*(2*a*\cos(2*x) - a)*\sin(3*x) + 2*a*\sin(x))*\sqrt{-a}/(2*(2*\cos(2*x) - 1)*\cos(4*x) - \cos(4*x)^2 - 4*\cos(2*x)^2 - \sin(4*x)^2 + 4*\sin(4*x)*\sin(2*x) - 4*\sin(2*x)^2 + 4*\cos(2*x) - 1)$

Fricas [A] time = 0.487157, size = 136, normalized size = 2.96

$$\frac{\left(2a \cos(x) + (a \cos(x)^2 - a) \log\left(-\frac{\cos(x)-1}{\cos(x)+1}\right)\right) \sqrt{-\frac{a}{\cos(x)^2-1}}}{4 \sin(x)}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^2)^(3/2),x, algorithm="fricas")

[Out] $-1/4*(2*a*\cos(x) + (a*\cos(x)^2 - a)*\log(-(\cos(x) - 1)/(\cos(x) + 1)))*\sqrt{-a/(\cos(x)^2 - 1)}/\sin(x)$

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int (a \csc^2(x))^{\frac{3}{2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)**2)**(3/2),x)

[Out] Integral((a*csc(x)**2)**(3/2), x)

Giac [B] time = 1.32157, size = 97, normalized size = 2.11

$$\frac{1}{8} \left(2 \log \left(-\frac{\cos(x) - 1}{\cos(x) + 1} \right) \operatorname{sgn}(\sin(x)) - \frac{\left(\frac{2(\cos(x) - 1)\operatorname{sgn}(\sin(x))}{\cos(x) + 1} - \operatorname{sgn}(\sin(x)) \right) (\cos(x) + 1)}{\cos(x) - 1} - \frac{(\cos(x) - 1)\operatorname{sgn}(\sin(x))}{\cos(x) + 1} \right) a^{\frac{3}{2}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^2)^(3/2),x, algorithm="giac")

[Out] 1/8*(2*log(-(cos(x) - 1)/(cos(x) + 1))*sgn(sin(x)) - (2*(cos(x) - 1)*sgn(sin(x))/(cos(x) + 1) - sgn(sin(x)))*(cos(x) + 1)/(cos(x) - 1) - (cos(x) - 1)*sgn(sin(x))/(cos(x) + 1))*a^(3/2)

3.50 $\int \sqrt{a \csc^2(x)} dx$

Optimal. Leaf size=26

$$-\sqrt{a} \tanh^{-1} \left(\frac{\sqrt{a} \cot(x)}{\sqrt{a \csc^2(x)}} \right)$$

[Out] $-(\text{Sqrt}[a] * \text{ArcTanh}[(\text{Sqrt}[a] * \text{Cot}[x]) / \text{Sqrt}[a * \text{Csc}[x]^2]])$

Rubi [A] time = 0.0156433, antiderivative size = 26, normalized size of antiderivative = 1., number of steps used = 3, number of rules used = 3, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.3$, Rules used = {4122, 217, 206}

$$-\sqrt{a} \tanh^{-1} \left(\frac{\sqrt{a} \cot(x)}{\sqrt{a \csc^2(x)}} \right)$$

Antiderivative was successfully verified.

[In] $\text{Int}[\text{Sqrt}[a * \text{Csc}[x]^2], x]$

[Out] $-(\text{Sqrt}[a] * \text{ArcTanh}[(\text{Sqrt}[a] * \text{Cot}[x]) / \text{Sqrt}[a * \text{Csc}[x]^2]])$

Rule 4122

$\text{Int}[(b_*) * \sec[(e_*) + (f_*) * (x_*)^2]^{(p_*)}, x_Symbol] \rightarrow \text{With}[\{ff = \text{FreeFactors}[\text{Tan}[e + f * x], x]\}, \text{Dist}[(b * ff) / f, \text{Subst}[\text{Int}[(b + b * ff^2 * x^2)^{(p - 1)}, x], x, \text{Tan}[e + f * x] / ff], x] /; \text{FreeQ}[\{b, e, f, p\}, x] \&\& \text{!IntegerQ}[p]$

Rule 217

$\text{Int}[1 / \text{Sqrt}[(a_*) + (b_*) * (x_*)^2], x_Symbol] \rightarrow \text{Subst}[\text{Int}[1 / (1 - b * x^2), x], x, x / \text{Sqrt}[a + b * x^2]] /; \text{FreeQ}[\{a, b\}, x] \&\& \text{!GtQ}[a, 0]$

Rule 206

$\text{Int}[(a_*) + (b_*) * (x_*)^2]^{(-1)}, x_Symbol] \rightarrow \text{Simp}[(1 * \text{ArcTanh}[(\text{Rt}[-b, 2] * x) / \text{Rt}[a, 2]]) / (\text{Rt}[a, 2] * \text{Rt}[-b, 2]), x] /; \text{FreeQ}[\{a, b\}, x] \&\& \text{NegQ}[a / b] \&\& (\text{GtQ}[a, 0] \parallel \text{LtQ}[b, 0])$

Rubi steps

$$\begin{aligned}
\int \sqrt{a \csc^2(x)} dx &= -\left(a \operatorname{Subst}\left(\int \frac{1}{\sqrt{a+ax^2}} dx, x, \cot(x)\right)\right) \\
&= -\left(a \operatorname{Subst}\left(\int \frac{1}{1-ax^2} dx, x, \frac{\cot(x)}{\sqrt{a \csc^2(x)}}\right)\right) \\
&= -\sqrt{a} \tanh^{-1}\left(\frac{\sqrt{a} \cot(x)}{\sqrt{a \csc^2(x)}}\right)
\end{aligned}$$

Mathematica [A] time = 0.0160915, size = 30, normalized size = 1.15

$$\sin(x)\sqrt{a \csc^2(x)}\left(\log\left(\sin\left(\frac{x}{2}\right)\right) - \log\left(\cos\left(\frac{x}{2}\right)\right)\right)$$

Antiderivative was successfully verified.

[In] Integrate[Sqrt[a*Csc[x]^2], x]

[Out] Sqrt[a*Csc[x]^2]*(-Log[Cos[x/2]] + Log[Sin[x/2]])*Sin[x]

Maple [A] time = 0.126, size = 32, normalized size = 1.2

$$\frac{\sqrt{4} \sin(x)}{2} \sqrt{\frac{a}{(\cos(x))^2 - 1}} \ln\left(-\frac{-1 + \cos(x)}{\sin(x)}\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int((a*csc(x)^2)^(1/2), x)

[Out] 1/2*4^(1/2)*sin(x)*(-a/(cos(x)^2-1))^(1/2)*ln(-(-1+cos(x))/sin(x))

Maxima [A] time = 1.6668, size = 32, normalized size = 1.23

$$-\sqrt{-a}(\arctan(\sin(x), \cos(x) + 1) - \arctan(\sin(x), \cos(x) - 1))$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^2)^(1/2), x, algorithm="maxima")

[Out] $-\sqrt{-a} \cdot (\arctan2(\sin(x), \cos(x) + 1) - \arctan2(\sin(x), \cos(x) - 1))$

Fricas [A] time = 0.494227, size = 188, normalized size = 7.23

$$\left[\frac{1}{2} \sqrt{-\frac{a}{\cos(x)^2 - 1}} \log\left(-\frac{\cos(x) - 1}{\cos(x) + 1}\right) \sin(x), \sqrt{-a} \arctan\left(\frac{\sqrt{-a} \sqrt{-\frac{a}{\cos(x)^2 - 1}} \cos(x) \sin(x)}{a}\right) \right]$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate((a*csc(x)^2)^(1/2),x, algorithm="fricas")`

[Out] $[1/2 \sqrt{-a/(\cos(x)^2 - 1)} \log(-(\cos(x) - 1)/(\cos(x) + 1)) \sin(x), \sqrt{-a} \arctan(\sqrt{-a} \sqrt{-a/(\cos(x)^2 - 1)} \cos(x) \sin(x)/a)]$

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \sqrt{a \csc^2(x)} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate((a*csc(x)**2)**(1/2),x)`

[Out] `Integral(sqrt(a*csc(x)**2), x)`

Giac [A] time = 1.23949, size = 18, normalized size = 0.69

$$\sqrt{a} \log\left(\left|\tan\left(\frac{1}{2}x\right)\right|\right) \operatorname{sgn}(\sin(x))$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate((a*csc(x)^2)^(1/2),x, algorithm="giac")`

[Out] `sqrt(a)*log(abs(tan(1/2*x)))*sgn(sin(x))`

$$3.51 \quad \int \frac{1}{\sqrt{a \csc^2(x)}} dx$$

Optimal. Leaf size=14

$$-\frac{\cot(x)}{\sqrt{a \csc^2(x)}}$$

[Out] -(Cot[x]/Sqrt[a*Csc[x]^2])

Rubi [A] time = 0.0134393, antiderivative size = 14, normalized size of antiderivative = 1., number of steps used = 2, number of rules used = 2, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.2$, Rules used = {4122, 191}

$$-\frac{\cot(x)}{\sqrt{a \csc^2(x)}}$$

Antiderivative was successfully verified.

[In] Int[1/Sqrt[a*Csc[x]^2],x]

[Out] -(Cot[x]/Sqrt[a*Csc[x]^2])

Rule 4122

```
Int[((b_.)*sec[(e_.) + (f_.)*(x_)]^2)^(p_), x_Symbol] :> With[{ff = FreeFactors[Tan[e + f*x], x]}, Dist[(b*ff)/f, Subst[Int[(b + b*ff^2*x^2)^(p - 1), x], x, Tan[e + f*x]/ff], x] /; FreeQ[{b, e, f, p}, x] && !IntegerQ[p]
```

Rule 191

```
Int[((a_) + (b_.)*(x_)^(n_))^(p_), x_Symbol] :> Simp[(x*(a + b*x^n)^(p + 1))/a, x] /; FreeQ[{a, b, n, p}, x] && EqQ[1/n + p + 1, 0]
```

Rubi steps

$$\int \frac{1}{\sqrt{a \csc^2(x)}} dx = - \left(a \operatorname{Subst} \left(\int \frac{1}{(a + ax^2)^{3/2}} dx, x, \cot(x) \right) \right)$$

$$= - \frac{\cot(x)}{\sqrt{a \csc^2(x)}}$$

Mathematica [A] time = 0.0064168, size = 14, normalized size = 1.

$$- \frac{\cot(x)}{\sqrt{a \csc^2(x)}}$$

Antiderivative was successfully verified.

[In] Integrate[1/Sqrt[a*Csc[x]^2],x]

[Out] -(Cot[x]/Sqrt[a*Csc[x]^2])

Maple [B] time = 0.132, size = 27, normalized size = 1.9

$$\frac{\sqrt{4} \sin(x)}{-2 + 2 \cos(x)} \frac{1}{\sqrt{-\frac{a}{(\cos(x))^2 - 1}}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(1/(a*csc(x)^2)^(1/2),x)

[Out] 1/2*4^(1/2)*sin(x)/(-a/(cos(x)^2-1))^(1/2)/(-1+cos(x))

Maxima [A] time = 1.49698, size = 18, normalized size = 1.29

$$- \frac{1}{\sqrt{\tan(x)^2 + 1} \sqrt{a}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(a*csc(x)^2)^(1/2),x, algorithm="maxima")

[Out] -1/(sqrt(tan(x)^2 + 1)*sqrt(a))

Fricas [A] time = 0.468744, size = 57, normalized size = 4.07

$$-\frac{\sqrt{-\frac{a}{\cos(x)^2-1}} \cos(x) \sin(x)}{a}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(a*csc(x)^2)^(1/2),x, algorithm="fricas")

[Out] -sqrt(-a/(cos(x)^2 - 1))*cos(x)*sin(x)/a

Sympy [A] time = 0.789281, size = 17, normalized size = 1.21

$$-\frac{\cot(x)}{\sqrt{a}\sqrt{\csc^2(x)}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(a*csc(x)**2)**(1/2),x)

[Out] -cot(x)/(sqrt(a)*sqrt(csc(x)**2))

Giac [B] time = 1.28229, size = 46, normalized size = 3.29

$$\frac{2 \operatorname{sgn}(\sin(x))}{\sqrt{a}} + \frac{2}{\sqrt{a} \left(\frac{\cos(x)-1}{\cos(x)+1} - 1 \right) \operatorname{sgn}(\sin(x))}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(a*csc(x)^2)^(1/2),x, algorithm="giac")

[Out] 2*sgn(sin(x))/sqrt(a) + 2/(sqrt(a)*((cos(x) - 1)/(cos(x) + 1) - 1)*sgn(sin(x)))

$$3.52 \quad \int \frac{1}{(a \csc^2(x))^{3/2}} dx$$

Optimal. Leaf size=36

$$-\frac{2 \cot(x)}{3a\sqrt{a \csc^2(x)}} - \frac{\cot(x)}{3(a \csc^2(x))^{3/2}}$$

[Out] $-\text{Cot}[x]/(3*(a*\text{Csc}[x]^2)^{(3/2)}) - (2*\text{Cot}[x])/(3*a*\text{Sqrt}[a*\text{Csc}[x]^2])$

Rubi [A] time = 0.0183318, antiderivative size = 36, normalized size of antiderivative = 1., number of steps used = 3, number of rules used = 3, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.3$, Rules used = {4122, 192, 191}

$$-\frac{2 \cot(x)}{3a\sqrt{a \csc^2(x)}} - \frac{\cot(x)}{3(a \csc^2(x))^{3/2}}$$

Antiderivative was successfully verified.

[In] $\text{Int}[(a*\text{Csc}[x]^2)^{-3/2}, x]$

[Out] $-\text{Cot}[x]/(3*(a*\text{Csc}[x]^2)^{(3/2)}) - (2*\text{Cot}[x])/(3*a*\text{Sqrt}[a*\text{Csc}[x]^2])$

Rule 4122

$\text{Int}[(b_*)*\text{sec}[(e_*) + (f_*)*(x_*)^2]^{(p_*)}, x_Symbol] \rightarrow \text{With}[\{\text{ff} = \text{FreeFactors}[\text{Tan}[e + f*x], x]\}, \text{Dist}[(b*\text{ff})/f, \text{Subst}[\text{Int}[(b + b*\text{ff}^2*x^2)^{(p - 1)}, x], x, \text{Tan}[e + f*x]/\text{ff}], x] /; \text{FreeQ}[\{b, e, f, p\}, x] \&\& \text{!IntegerQ}[p]$

Rule 192

$\text{Int}[(a_*) + (b_*)*(x_*)^{(n_*)}]^{(p_*)}, x_Symbol] \rightarrow -\text{Simp}[(x*(a + b*x^n)^{(p + 1)})/(a*n*(p + 1)), x] + \text{Dist}[(n*(p + 1) + 1)/(a*n*(p + 1)), \text{Int}[(a + b*x^n)^{(p + 1)}, x], x] /; \text{FreeQ}[\{a, b, n, p\}, x] \&\& \text{ILtQ}[\text{Simplify}[1/n + p + 1], 0] \&\& \text{NeQ}[p, -1]$

Rule 191

$\text{Int}[(a_*) + (b_*)*(x_*)^{(n_*)}]^{(p_*)}, x_Symbol] \rightarrow \text{Simp}[(x*(a + b*x^n)^{(p + 1)})/a, x] /; \text{FreeQ}[\{a, b, n, p\}, x] \&\& \text{EqQ}[1/n + p + 1, 0]$

Rubi steps

$$\begin{aligned}
\int \frac{1}{(a \csc^2(x))^{3/2}} dx &= - \left(a \operatorname{Subst} \left(\int \frac{1}{(a + ax^2)^{5/2}} dx, x, \cot(x) \right) \right) \\
&= - \frac{\cot(x)}{3 (a \csc^2(x))^{3/2}} - \frac{2}{3} \operatorname{Subst} \left(\int \frac{1}{(a + ax^2)^{3/2}} dx, x, \cot(x) \right) \\
&= - \frac{\cot(x)}{3 (a \csc^2(x))^{3/2}} - \frac{2 \cot(x)}{3a \sqrt{a \csc^2(x)}}
\end{aligned}$$

Mathematica [A] time = 0.0214471, size = 27, normalized size = 0.75

$$\frac{(\cos(3x) - 9 \cos(x)) \csc^3(x)}{12 (a \csc^2(x))^{3/2}}$$

Antiderivative was successfully verified.

[In] Integrate[(a*Csc[x]^2)^(-3/2), x]

[Out] ((-9*Cos[x] + Cos[3*x])*Csc[x]^3)/(12*(a*Csc[x]^2)^(3/2))

Maple [A] time = 0.076, size = 31, normalized size = 0.9

$$\frac{\sqrt{4} \sin(x) (\cos(x) - 2)}{6 (-1 + \cos(x))^2} \left(-\frac{a}{(\cos(x))^2 - 1} \right)^{-\frac{3}{2}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(1/(a*csc(x)^2)^(3/2), x)

[Out] 1/6*4^(1/2)*sin(x)*(cos(x)-2)/(-1+cos(x))^2/(-a/(cos(x)^2-1))^(3/2)

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(a \csc(x)^2)^{\frac{3}{2}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(a*csc(x)^2)^(3/2),x, algorithm="maxima")

[Out] integrate((a*csc(x)^2)^(-3/2), x)

Fricas [A] time = 0.471213, size = 84, normalized size = 2.33

$$\frac{(\cos(x)^3 - 3 \cos(x)) \sqrt{-\frac{a}{\cos(x)^2 - 1}} \sin(x)}{3 a^2}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(a*csc(x)^2)^(3/2),x, algorithm="fricas")

[Out] 1/3*(cos(x)^3 - 3*cos(x))*sqrt(-a/(cos(x)^2 - 1))*sin(x)/a^2

Sympy [A] time = 3.57798, size = 39, normalized size = 1.08

$$-\frac{2 \cot^3(x)}{3 a^{\frac{3}{2}} (\csc^2(x))^{\frac{3}{2}}} - \frac{\cot(x)}{a^{\frac{3}{2}} (\csc^2(x))^{\frac{3}{2}}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(a*csc(x)**2)**(3/2),x)

[Out] -2*cot(x)**3/(3*a**(3/2)*(csc(x)**2)**(3/2)) - cot(x)/(a**(3/2)*(csc(x)**2)**(3/2))

Giac [A] time = 1.38485, size = 58, normalized size = 1.61

$$-\frac{4 \left(\frac{3 \operatorname{sgn}\left(\tan\left(\frac{1}{2}x\right)\right) \tan\left(\frac{1}{2}x\right)^2 + \operatorname{sgn}\left(\tan\left(\frac{1}{2}x\right)\right)}{\left(\tan\left(\frac{1}{2}x\right)^2 + 1\right)^3} - \operatorname{sgn}\left(\tan\left(\frac{1}{2}x\right)\right) \right)}{3 a^{\frac{3}{2}}}$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/(a*csc(x)^2)^(3/2),x, algorithm="giac")
```

```
[Out] -4/3*((3*sgn(tan(1/2*x))*tan(1/2*x)^2 + sgn(tan(1/2*x)))/(tan(1/2*x)^2 + 1)
^3 - sgn(tan(1/2*x)))/a^(3/2)
```

$$3.53 \quad \int \frac{1}{(a \csc^2(x))^{5/2}} dx$$

Optimal. Leaf size=55

$$-\frac{8 \cot(x)}{15a^2 \sqrt{a \csc^2(x)}} - \frac{4 \cot(x)}{15a (a \csc^2(x))^{3/2}} - \frac{\cot(x)}{5 (a \csc^2(x))^{5/2}}$$

[Out] $-\text{Cot}[x]/(5*(a*\text{Csc}[x]^2)^{(5/2)}) - (4*\text{Cot}[x])/(15*a*(a*\text{Csc}[x]^2)^{(3/2)}) - (8*\text{Cot}[x])/(15*a^2*\text{Sqrt}[a*\text{Csc}[x]^2])$

Rubi [A] time = 0.026984, antiderivative size = 55, normalized size of antiderivative = 1., number of steps used = 4, number of rules used = 3, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.3$, Rules used = {4122, 192, 191}

$$-\frac{8 \cot(x)}{15a^2 \sqrt{a \csc^2(x)}} - \frac{4 \cot(x)}{15a (a \csc^2(x))^{3/2}} - \frac{\cot(x)}{5 (a \csc^2(x))^{5/2}}$$

Antiderivative was successfully verified.

[In] $\text{Int}[(a*\text{Csc}[x]^2)^{(-5/2)}, x]$

[Out] $-\text{Cot}[x]/(5*(a*\text{Csc}[x]^2)^{(5/2)}) - (4*\text{Cot}[x])/(15*a*(a*\text{Csc}[x]^2)^{(3/2)}) - (8*\text{Cot}[x])/(15*a^2*\text{Sqrt}[a*\text{Csc}[x]^2])$

Rule 4122

$\text{Int}[(b_*)*\text{sec}[(e_*) + (f_*)*(x_*)]^2)^{(p_*)}, x_Symbol] \rightarrow \text{With}[\{ff = \text{FreeFactors}[\text{Tan}[e + f*x], x]\}, \text{Dist}[(b*ff)/f, \text{Subst}[\text{Int}[(b + b*ff^2*x^2)^{(p - 1)}, x], x, \text{Tan}[e + f*x]/ff], x] /; \text{FreeQ}[\{b, e, f, p\}, x] \&\amp; !\text{IntegerQ}[p]$

Rule 192

$\text{Int}[(a_*) + (b_*)*(x_*)^{(n_*)})^{(p_*)}, x_Symbol] \rightarrow -\text{Simp}[(x*(a + b*x^n)^{(p + 1)})/(a*n*(p + 1)), x] + \text{Dist}[(n*(p + 1) + 1)/(a*n*(p + 1)), \text{Int}[(a + b*x^n)^{(p + 1)}, x], x] /; \text{FreeQ}[\{a, b, n, p\}, x] \&\amp; \text{ILtQ}[\text{Simplify}[1/n + p + 1], 0] \&\amp; \text{NeQ}[p, -1]$

Rule 191

```
Int[((a_) + (b_.)*(x_)^(n_))^(p_), x_Symbol] := Simp[(x*(a + b*x^n)^(p + 1)
)/a, x] /; FreeQ[{a, b, n, p}, x] && EqQ[1/n + p + 1, 0]
```

Rubi steps

$$\begin{aligned} \int \frac{1}{(a \csc^2(x))^{5/2}} dx &= - \left(a \operatorname{Subst} \left(\int \frac{1}{(a + ax^2)^{7/2}} dx, x, \cot(x) \right) \right) \\ &= - \frac{\cot(x)}{5 (a \csc^2(x))^{5/2}} - \frac{4}{5} \operatorname{Subst} \left(\int \frac{1}{(a + ax^2)^{5/2}} dx, x, \cot(x) \right) \\ &= - \frac{\cot(x)}{5 (a \csc^2(x))^{5/2}} - \frac{4 \cot(x)}{15a (a \csc^2(x))^{3/2}} - \frac{8 \operatorname{Subst} \left(\int \frac{1}{(a+ax^2)^{3/2}} dx, x, \cot(x) \right)}{15a} \\ &= - \frac{\cot(x)}{5 (a \csc^2(x))^{5/2}} - \frac{4 \cot(x)}{15a (a \csc^2(x))^{3/2}} - \frac{8 \cot(x)}{15a^2 \sqrt{a \csc^2(x)}} \end{aligned}$$

Mathematica [A] time = 0.0342015, size = 36, normalized size = 0.65

$$\frac{\sin(x)(150 \cos(x) - 25 \cos(3x) + 3 \cos(5x))\sqrt{a \csc^2(x)}}{240a^3}$$

Antiderivative was successfully verified.

```
[In] Integrate[(a*Csc[x]^2)^(-5/2), x]
```

```
[Out] -((150*Cos[x] - 25*Cos[3*x] + 3*Cos[5*x])*Sqrt[a*Csc[x]^2]*Sin[x])/(240*a^3)
```

Maple [A] time = 0.081, size = 39, normalized size = 0.7

$$\frac{\sqrt{4} \sin(x) (3 (\cos(x))^2 - 9 \cos(x) + 8)}{30 (-1 + \cos(x))^3} \left(-\frac{a}{(\cos(x))^2 - 1} \right)^{-\frac{5}{2}}$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] int(1/(a*csc(x)^2)^(5/2), x)
```

[Out] $1/30*4^{(1/2)}*\sin(x)*(3*\cos(x)^2-9*\cos(x)+8)/(-1+\cos(x))^3/(-a/(\cos(x)^2-1))^{(5/2)}$

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(a \csc(x)^2)^{5/2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(a*csc(x)^2)^(5/2),x, algorithm="maxima")`

[Out] `integrate((a*csc(x)^2)^(-5/2), x)`

Fricas [A] time = 0.480975, size = 109, normalized size = 1.98

$$\frac{(3 \cos(x)^5 - 10 \cos(x)^3 + 15 \cos(x)) \sqrt{-\frac{a}{\cos(x)^2 - 1}} \sin(x)}{15 a^3}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(a*csc(x)^2)^(5/2),x, algorithm="fricas")`

[Out] $-1/15*(3*\cos(x)^5 - 10*\cos(x)^3 + 15*\cos(x))*\sqrt{-a/(\cos(x)^2 - 1)}*\sin(x)/a^3$

Sympy [A] time = 32.7597, size = 61, normalized size = 1.11

$$-\frac{8 \cot^5(x)}{15 a^{5/2} (\csc^2(x))^{5/2}} - \frac{4 \cot^3(x)}{3 a^{5/2} (\csc^2(x))^{5/2}} - \frac{\cot(x)}{a^{5/2} (\csc^2(x))^{5/2}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(a*csc(x)**2)**(5/2),x)`

[Out] $-8*\cot(x)**5/(15*a**(5/2)*(csc(x)**2)**(5/2)) - 4*\cot(x)**3/(3*a**(5/2)*(csc(x)**2)**(5/2)) - \cot(x)/(a**(5/2)*(csc(x)**2)**(5/2))$

Giac [A] time = 1.44929, size = 76, normalized size = 1.38

$$16 \left(\frac{10 \operatorname{sgn}\left(\tan\left(\frac{1}{2}x\right)\right) \tan\left(\frac{1}{2}x\right)^4 + 5 \operatorname{sgn}\left(\tan\left(\frac{1}{2}x\right)\right) \tan\left(\frac{1}{2}x\right)^2 + \operatorname{sgn}\left(\tan\left(\frac{1}{2}x\right)\right)}{\left(\tan\left(\frac{1}{2}x\right)^2 + 1\right)^5} - \operatorname{sgn}\left(\tan\left(\frac{1}{2}x\right)\right) \right) \\ \frac{1}{15 a^{\frac{5}{2}}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(a*csc(x)^2)^(5/2),x, algorithm="giac")`

[Out] $-16/15*((10*\operatorname{sgn}(\tan(1/2*x))*\tan(1/2*x)^4 + 5*\operatorname{sgn}(\tan(1/2*x))*\tan(1/2*x)^2 + \operatorname{sgn}(\tan(1/2*x)))/(\tan(1/2*x)^2 + 1)^5 - \operatorname{sgn}(\tan(1/2*x)))/a^{(5/2)}$

$$3.54 \quad \int \frac{1}{(a \csc^2(x))^{7/2}} dx$$

Optimal. Leaf size=74

$$-\frac{16 \cot(x)}{35a^3 \sqrt{a \csc^2(x)}} - \frac{8 \cot(x)}{35a^2 (a \csc^2(x))^{3/2}} - \frac{6 \cot(x)}{35a (a \csc^2(x))^{5/2}} - \frac{\cot(x)}{7 (a \csc^2(x))^{7/2}}$$

[Out] $-\text{Cot}[x]/(7*(a*\text{Csc}[x]^2)^{(7/2)}) - (6*\text{Cot}[x])/(35*a*(a*\text{Csc}[x]^2)^{(5/2)}) - (8*\text{Cot}[x])/(35*a^2*(a*\text{Csc}[x]^2)^{(3/2)}) - (16*\text{Cot}[x])/(35*a^3*\text{Sqrt}[a*\text{Csc}[x]^2])$

Rubi [A] time = 0.0357382, antiderivative size = 74, normalized size of antiderivative = 1., number of steps used = 5, number of rules used = 3, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.3$, Rules used = {4122, 192, 191}

$$-\frac{16 \cot(x)}{35a^3 \sqrt{a \csc^2(x)}} - \frac{8 \cot(x)}{35a^2 (a \csc^2(x))^{3/2}} - \frac{6 \cot(x)}{35a (a \csc^2(x))^{5/2}} - \frac{\cot(x)}{7 (a \csc^2(x))^{7/2}}$$

Antiderivative was successfully verified.

[In] $\text{Int}[(a*\text{Csc}[x]^2)^{(-7/2)}, x]$

[Out] $-\text{Cot}[x]/(7*(a*\text{Csc}[x]^2)^{(7/2)}) - (6*\text{Cot}[x])/(35*a*(a*\text{Csc}[x]^2)^{(5/2)}) - (8*\text{Cot}[x])/(35*a^2*(a*\text{Csc}[x]^2)^{(3/2)}) - (16*\text{Cot}[x])/(35*a^3*\text{Sqrt}[a*\text{Csc}[x]^2])$

Rule 4122

$\text{Int}[(b_*)*\text{sec}(e_*) + (f_*)(x_*)^2)^{(p_*)}, x_Symbol] \rightarrow \text{With}[\{ff = \text{FreeFactors}[\text{Tan}[e + f*x], x]\}, \text{Dist}[(b*ff)/f, \text{Subst}[\text{Int}[(b + b*ff^2*x^2)^{(p - 1)}, x], x, \text{Tan}[e + f*x]/ff, x]] /; \text{FreeQ}\{b, e, f, p\}, x] \&\& !\text{IntegerQ}[p]$

Rule 192

$\text{Int}[(a_*) + (b_*)(x_*)^{(n_*)})^{(p_*)}, x_Symbol] \rightarrow -\text{Simp}[(x*(a + b*x^n)^{(p + 1)})/(a*n*(p + 1)), x] + \text{Dist}[(n*(p + 1) + 1)/(a*n*(p + 1)), \text{Int}[(a + b*x^n)^{(p + 1)}, x], x] /; \text{FreeQ}\{a, b, n, p\}, x] \&\& \text{ILtQ}[\text{Simplify}[1/n + p + 1], 0] \&\& \text{NeQ}[p, -1]$

Rule 191

Int[((a_) + (b_.)*(x_)^(n_))^(p_), x_Symbol] := Simp[(x*(a + b*x^n)^(p + 1))/a, x] /; FreeQ[{a, b, n, p}, x] && EqQ[1/n + p + 1, 0]

Rubi steps

$$\begin{aligned}
 \int \frac{1}{(a \csc^2(x))^{7/2}} dx &= - \left(a \operatorname{Subst} \left(\int \frac{1}{(a + ax^2)^{9/2}} dx, x, \cot(x) \right) \right) \\
 &= - \frac{\cot(x)}{7 (a \csc^2(x))^{7/2}} - \frac{6}{7} \operatorname{Subst} \left(\int \frac{1}{(a + ax^2)^{7/2}} dx, x, \cot(x) \right) \\
 &= - \frac{\cot(x)}{7 (a \csc^2(x))^{7/2}} - \frac{6 \cot(x)}{35a (a \csc^2(x))^{5/2}} - \frac{24 \operatorname{Subst} \left(\int \frac{1}{(a+ax^2)^{5/2}} dx, x, \cot(x) \right)}{35a} \\
 &= - \frac{\cot(x)}{7 (a \csc^2(x))^{7/2}} - \frac{6 \cot(x)}{35a (a \csc^2(x))^{5/2}} - \frac{8 \cot(x)}{35a^2 (a \csc^2(x))^{3/2}} - \frac{16 \operatorname{Subst} \left(\int \frac{1}{(a+ax^2)^{3/2}} dx, x, \cot(x) \right)}{35a^2} \\
 &= - \frac{\cot(x)}{7 (a \csc^2(x))^{7/2}} - \frac{6 \cot(x)}{35a (a \csc^2(x))^{5/2}} - \frac{8 \cot(x)}{35a^2 (a \csc^2(x))^{3/2}} - \frac{16 \cot(x)}{35a^3 \sqrt{a \csc^2(x)}}
 \end{aligned}$$

Mathematica [A] time = 0.0446459, size = 42, normalized size = 0.57

$$\frac{\sin(x)(-1225 \cos(x) + 245 \cos(3x) - 49 \cos(5x) + 5 \cos(7x))\sqrt{a \csc^2(x)}}{2240a^4}$$

Antiderivative was successfully verified.

[In] Integrate[(a*Csc[x]^2)^(-7/2), x]

[Out] ((-1225*Cos[x] + 245*Cos[3*x] - 49*Cos[5*x] + 5*Cos[7*x])*Sqrt[a*Csc[x]^2]*Sin[x])/(2240*a^4)

Maple [A] time = 0.076, size = 45, normalized size = 0.6

$$\frac{\sqrt{4} \sin(x) (5 (\cos(x))^3 - 20 (\cos(x))^2 + 29 \cos(x) - 16)}{70 (-1 + \cos(x))^4} \left(-\frac{a}{(\cos(x))^2 - 1} \right)^{-\frac{7}{2}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `int(1/(a*csc(x)^2)^(7/2),x)`

[Out] $1/70*4^{(1/2)}*\sin(x)*(5*\cos(x)^3-20*\cos(x)^2+29*\cos(x)-16)/(-1+\cos(x))^{4/(-a/(\cos(x)^2-1))^{(7/2)}}$

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(a \csc(x)^2)^{7/2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(a*csc(x)^2)^(7/2),x, algorithm="maxima")`

[Out] `integrate((a*csc(x)^2)^(-7/2), x)`

Fricas [A] time = 0.48903, size = 127, normalized size = 1.72

$$\frac{(5 \cos(x)^7 - 21 \cos(x)^5 + 35 \cos(x)^3 - 35 \cos(x)) \sqrt{-\frac{a}{\cos(x)^2 - 1}} \sin(x)}{35 a^4}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(a*csc(x)^2)^(7/2),x, algorithm="fricas")`

[Out] $1/35*(5*\cos(x)^7 - 21*\cos(x)^5 + 35*\cos(x)^3 - 35*\cos(x))*\sqrt{-a/(\cos(x)^2 - 1)}*\sin(x)/a^4$

Sympy [F(-1)] time = 0., size = 0, normalized size = 0.

Timed out

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(a*csc(x)**2)**(7/2),x)

[Out] Timed out

Giac [A] time = 1.48023, size = 93, normalized size = 1.26

$$32 \frac{\left(\frac{35 \operatorname{sgn}\left(\tan\left(\frac{1}{2}x\right)\right) \tan\left(\frac{1}{2}x\right)^6 + 21 \operatorname{sgn}\left(\tan\left(\frac{1}{2}x\right)\right) \tan\left(\frac{1}{2}x\right)^4 + 7 \operatorname{sgn}\left(\tan\left(\frac{1}{2}x\right)\right) \tan\left(\frac{1}{2}x\right)^2 + \operatorname{sgn}\left(\tan\left(\frac{1}{2}x\right)\right)}{\left(\tan\left(\frac{1}{2}x\right)^2 + 1\right)^7} - \operatorname{sgn}\left(\tan\left(\frac{1}{2}x\right)\right) \right)}{35 a^{\frac{7}{2}}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(a*csc(x)^2)^(7/2),x, algorithm="giac")

[Out] -32/35*((35*sgn(tan(1/2*x))*tan(1/2*x)^6 + 21*sgn(tan(1/2*x))*tan(1/2*x)^4 + 7*sgn(tan(1/2*x))*tan(1/2*x)^2 + sgn(tan(1/2*x)))/(tan(1/2*x)^2 + 1)^7 - sgn(tan(1/2*x)))/a^(7/2)

3.55 $\int (a \csc^3(x))^{5/2} dx$

Optimal. Leaf size=123

$$-\frac{2}{13}a^2 \cot(x) \csc^4(x) \sqrt{a \csc^3(x)} - \frac{22}{117}a^2 \cot(x) \csc^2(x) \sqrt{a \csc^3(x)} - \frac{154}{585}a^2 \cot(x) \sqrt{a \csc^3(x)} - \frac{154}{195}a^2 \sin(x) \cos(x) \sqrt{a \csc^3(x)}$$

[Out] $(-154*a^2*\text{Cot}[x]*\text{Sqrt}[a*\text{Csc}[x]^3])/585 - (22*a^2*\text{Cot}[x]*\text{Csc}[x]^2*\text{Sqrt}[a*\text{Csc}[x]^3])/117 - (2*a^2*\text{Cot}[x]*\text{Csc}[x]^4*\text{Sqrt}[a*\text{Csc}[x]^3])/13 - (154*a^2*\text{Cos}[x]*\text{Sqrt}[a*\text{Csc}[x]^3]*\text{Sin}[x])/195 + (154*a^2*\text{Sqrt}[a*\text{Csc}[x]^3]*\text{EllipticE}[\text{Pi}/4 - x/2, 2]*\text{Sin}[x]^{(3/2)})/195$

Rubi [A] time = 0.0595877, antiderivative size = 123, normalized size of antiderivative = 1., number of steps used = 7, number of rules used = 4, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.4$, Rules used = {4123, 3768, 3771, 2639}

$$-\frac{2}{13}a^2 \cot(x) \csc^4(x) \sqrt{a \csc^3(x)} - \frac{22}{117}a^2 \cot(x) \csc^2(x) \sqrt{a \csc^3(x)} - \frac{154}{585}a^2 \cot(x) \sqrt{a \csc^3(x)} - \frac{154}{195}a^2 \sin(x) \cos(x) \sqrt{a \csc^3(x)}$$

Antiderivative was successfully verified.

[In] Int[(a*Csc[x]^3)^(5/2), x]

[Out] $(-154*a^2*\text{Cot}[x]*\text{Sqrt}[a*\text{Csc}[x]^3])/585 - (22*a^2*\text{Cot}[x]*\text{Csc}[x]^2*\text{Sqrt}[a*\text{Csc}[x]^3])/117 - (2*a^2*\text{Cot}[x]*\text{Csc}[x]^4*\text{Sqrt}[a*\text{Csc}[x]^3])/13 - (154*a^2*\text{Cos}[x]*\text{Sqrt}[a*\text{Csc}[x]^3]*\text{Sin}[x])/195 + (154*a^2*\text{Sqrt}[a*\text{Csc}[x]^3]*\text{EllipticE}[\text{Pi}/4 - x/2, 2]*\text{Sin}[x]^{(3/2)})/195$

Rule 4123

Int[((b_.)*((c_.)*sec[(e_.) + (f_.)*(x_)])^(n_))^(p_), x_Symbol] := Dist[(b^IntPart[p]*(b*(c*Sec[e + f*x])^n)^FracPart[p])/(c*Sec[e + f*x])^(n*FracPart[p]), Int[(c*Sec[e + f*x])^(n*p), x], x] /; FreeQ[{b, c, e, f, n, p}, x] & !IntegerQ[p]

Rule 3768

Int[(csc[(c_.) + (d_.)*(x_)])*(b_.)^(n_), x_Symbol] := -Simp[(b*Cos[c + d*x])*(b*Csc[c + d*x])^(n - 1)/(d*(n - 1)), x] + Dist[(b^2*(n - 2))/(n - 1), Int[(b*Csc[c + d*x])^(n - 2), x], x] /; FreeQ[{b, c, d}, x] && GtQ[n, 1] && IntegerQ[2*n]

Rule 3771

```
Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^n, x_Symbol] := Dist[(b*Csc[c + d*x]
)^n*Sin[c + d*x]^n, Int[1/Sin[c + d*x]^n, x], x] /; FreeQ[{b, c, d}, x] &&
EqQ[n^2, 1/4]
```

Rule 2639

```
Int[Sqrt[sin[(c_.) + (d_.)*(x_)]], x_Symbol] := Simp[(2*EllipticE[(1*(c - P
i/2 + d*x))/2, 2])/d, x] /; FreeQ[{c, d}, x]
```

Rubi steps

$$\begin{aligned} \int (a \csc^3(x))^{5/2} dx &= \frac{(a^2 \sqrt{a \csc^3(x)}) \int (-\csc(x))^{15/2} dx}{(-\csc(x))^{3/2}} \\ &= -\frac{2}{13} a^2 \cot(x) \csc^4(x) \sqrt{a \csc^3(x)} + \frac{(11a^2 \sqrt{a \csc^3(x)}) \int (-\csc(x))^{11/2} dx}{13(-\csc(x))^{3/2}} \\ &= -\frac{22}{117} a^2 \cot(x) \csc^2(x) \sqrt{a \csc^3(x)} - \frac{2}{13} a^2 \cot(x) \csc^4(x) \sqrt{a \csc^3(x)} + \frac{(77a^2 \sqrt{a \csc^3(x)}) \int (-\csc(x))^{7/2} dx}{117(-\csc(x))^{3/2}} \\ &= -\frac{154}{585} a^2 \cot(x) \sqrt{a \csc^3(x)} - \frac{22}{117} a^2 \cot(x) \csc^2(x) \sqrt{a \csc^3(x)} - \frac{2}{13} a^2 \cot(x) \csc^4(x) \sqrt{a \csc^3(x)} + \frac{(77a^2 \sqrt{a \csc^3(x)}) \int (-\csc(x))^{3/2} dx}{117(-\csc(x))^{3/2}} \\ &= -\frac{154}{585} a^2 \cot(x) \sqrt{a \csc^3(x)} - \frac{22}{117} a^2 \cot(x) \csc^2(x) \sqrt{a \csc^3(x)} - \frac{2}{13} a^2 \cot(x) \csc^4(x) \sqrt{a \csc^3(x)} - \frac{15}{19} a^2 \cot(x) \sqrt{a \csc^3(x)} \\ &= -\frac{154}{585} a^2 \cot(x) \sqrt{a \csc^3(x)} - \frac{22}{117} a^2 \cot(x) \csc^2(x) \sqrt{a \csc^3(x)} - \frac{2}{13} a^2 \cot(x) \csc^4(x) \sqrt{a \csc^3(x)} - \frac{15}{19} a^2 \cot(x) \sqrt{a \csc^3(x)} \\ &= -\frac{154}{585} a^2 \cot(x) \sqrt{a \csc^3(x)} - \frac{22}{117} a^2 \cot(x) \csc^2(x) \sqrt{a \csc^3(x)} - \frac{2}{13} a^2 \cot(x) \csc^4(x) \sqrt{a \csc^3(x)} - \frac{15}{19} a^2 \cot(x) \sqrt{a \csc^3(x)} \end{aligned}$$

Mathematica [A] time = 0.189496, size = 58, normalized size = 0.47

$$\frac{(a \csc^3(x))^{5/2} \left(-9414 \sin(2x) + 5346 \sin(4x) - 1694 \sin(6x) + 231 \sin(8x) + 29568 \sin^{\frac{15}{2}}(x) E\left(\frac{1}{4}(\pi - 2x) \middle| 2\right) \right)}{37440}$$

Antiderivative was successfully verified.

```
[In] Integrate[(a*Csc[x]^3)^(5/2), x]
```

```
[Out] ((a*Csc[x]^3)^(5/2)*(29568*EllipticE[(Pi - 2*x)/4, 2]*Sin[x]^(15/2) - 9414*
Sin[2*x] + 5346*Sin[4*x] - 1694*Sin[6*x] + 231*Sin[8*x]))/37440
```

Maple [C] time = 0.222, size = 1313, normalized size = 10.7

result too large to display

Verification of antiderivative is not currently implemented for this CAS.

[In] $\text{int}((a*\text{csc}(x)^3)^{(5/2}), x)$

[Out]
$$\begin{aligned} & -1/9360*8^{(1/2)}*(462*\cos(x)^7*2^{(1/2)}*(-I*(-1+\cos(x))/\sin(x))^{(1/2)}*((-I*\cos(x)+\sin(x)+I)/\sin(x))^{(1/2)}*\text{EllipticE}(((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}, 1/2*2^{(1/2)}) \\ & *((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}-231*\cos(x)^7*2^{(1/2)}*(-I*(-1+\cos(x))/\sin(x))^{(1/2)}*((-I*\cos(x)+\sin(x)+I)/\sin(x))^{(1/2)}*((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}*\text{EllipticF}(((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}, 1/2*2^{(1/2)}) \\ & +462*\cos(x)^6*2^{(1/2)}*(-I*(-1+\cos(x))/\sin(x))^{(1/2)}*((-I*\cos(x)+\sin(x)+I)/\sin(x))^{(1/2)}*\text{EllipticE}(((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}, 1/2*2^{(1/2)})*((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}-231*\cos(x)^6*2^{(1/2)}*(-I*(-1+\cos(x))/\sin(x))^{(1/2)} \\ & *((-I*\cos(x)+\sin(x)+I)/\sin(x))^{(1/2)}*((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}*\text{EllipticF}(((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}, 1/2*2^{(1/2)})-1386*\cos(x)^5*2^{(1/2)}*(-I*(-1+\cos(x))/\sin(x))^{(1/2)}*((-I*\cos(x)+\sin(x)+I)/\sin(x))^{(1/2)} \\ & *\text{EllipticE}(((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}, 1/2*2^{(1/2)})*((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}+693*\cos(x)^5*2^{(1/2)}*(-I*(-1+\cos(x))/\sin(x))^{(1/2)}*((-I*\cos(x)+\sin(x)+I)/\sin(x))^{(1/2)}*((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}*\text{EllipticF} \\ & (((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}, 1/2*2^{(1/2)})-1386*\cos(x)^4*2^{(1/2)}*(-I*(-1+\cos(x))/\sin(x))^{(1/2)}*((-I*\cos(x)+\sin(x)+I)/\sin(x))^{(1/2)}*\text{EllipticE}(((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}, 1/2*2^{(1/2)})*((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}+693*\cos(x)^4*2^{(1/2)} \\ & *(-I*(-1+\cos(x))/\sin(x))^{(1/2)}*((-I*\cos(x)+\sin(x)+I)/\sin(x))^{(1/2)}*((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}*\text{EllipticF}(((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}, 1/2*2^{(1/2)})+1386*\cos(x)^3*2^{(1/2)}*(-I*(-1+\cos(x))/\sin(x))^{(1/2)} \\ & *((-I*\cos(x)+\sin(x)+I)/\sin(x))^{(1/2)}*\text{EllipticE}(((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}, 1/2*2^{(1/2)})*((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}-693*\cos(x)^3*2^{(1/2)}*(-I*(-1+\cos(x))/\sin(x))^{(1/2)}*((-I*\cos(x)+\sin(x)+I)/\sin(x))^{(1/2)} \\ & *((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}*\text{EllipticF}(((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}, 1/2*2^{(1/2)})+1386*\cos(x)^2*2^{(1/2)}*(-I*(-1+\cos(x))/\sin(x))^{(1/2)}*((-I*\cos(x)+\sin(x)+I)/\sin(x))^{(1/2)}*\text{EllipticE}(((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}, 1/2*2^{(1/2)}) \\ & *((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}-693*\cos(x)^2*2^{(1/2)}*(-I*(-1+\cos(x))/\sin(x))^{(1/2)}*((-I*\cos(x)+\sin(x)+I)/\sin(x))^{(1/2)}*((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}*\text{EllipticF}(((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}, 1/2*2^{(1/2)}) \\ & -462*\cos(x)^6-462*\cos(x)*2^{(1/2)}*(-I*(-1+\cos(x))/\sin(x))^{(1/2)}*((-I*\cos(x)+\sin(x)+I)/\sin(x))^{(1/2)}*\text{EllipticE}(((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}, 1/2*2^{(1/2)})*((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}+231*\cos(x)*2^{(1/2)}*(-I*(-1+\cos(x))/\sin(x))^{(1/2)} \\ & *((-I*\cos(x)+\sin(x)+I)/\sin(x))^{(1/2)}*((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}*\text{EllipticF}(((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}, 1/2*2^{(1/2)})+154*\cos(x)^5-462*2^{(1/2)}*(-I*(-1+\cos(x))/\sin(x))^{(1/2)}*((-I*\cos(x)+\sin(x)+I) \end{aligned}$$

)/sin(x))^(1/2)*EllipticE(((I*cos(x)+sin(x)-I)/sin(x))^(1/2),1/2*2^(1/2))*(
(I*cos(x)+sin(x)-I)/sin(x))^(1/2)+231*2^(1/2)*(-I*(-1+cos(x))/sin(x))^(1/2)
*((-I*cos(x)+sin(x)+I)/sin(x))^(1/2)*((I*cos(x)+sin(x)-I)/sin(x))^(1/2)*Ell
ipticF(((I*cos(x)+sin(x)-I)/sin(x))^(1/2),1/2*2^(1/2))+1386*cos(x)^4-418*co
s(x)^3-1386*cos(x)^2+354*cos(x)+462)*sin(x)*(-2*a/sin(x)/(cos(x)^2-1))^(5/2
)

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int (a \csc(x)^3)^{\frac{5}{2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^3)^(5/2),x, algorithm="maxima")

[Out] integrate((a*csc(x)^3)^(5/2), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\sqrt{a \csc(x)^3} a^2 \csc(x)^6, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^3)^(5/2),x, algorithm="fricas")

[Out] integral(sqrt(a*csc(x)^3)*a^2*csc(x)^6, x)

Sympy [F(-1)] time = 0., size = 0, normalized size = 0.

Timed out

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)**3)**(5/2),x)

[Out] Timed out

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int (a \csc(x)^3)^{\frac{5}{2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^3)^(5/2),x, algorithm="giac")

[Out] integrate((a*csc(x)^3)^(5/2), x)

3.56 $\int \left(a \csc^3(x) \right)^{3/2} dx$

Optimal. Leaf size=71

$$-\frac{10}{21}a \sin^{\frac{3}{2}}(x) \operatorname{EllipticF}\left(\frac{\pi}{4} - \frac{x}{2}, 2\right) \sqrt{a \csc^3(x)} - \frac{10}{21}a \cos(x) \sqrt{a \csc^3(x)} - \frac{2}{7}a \cot(x) \csc(x) \sqrt{a \csc^3(x)}$$

[Out] $(-10*a*\cos[x]*\operatorname{Sqrt}[a*\csc[x]^3])/21 - (2*a*\cot[x]*\csc[x]*\operatorname{Sqrt}[a*\csc[x]^3])/7 - (10*a*\operatorname{Sqrt}[a*\csc[x]^3]*\operatorname{EllipticF}[\text{Pi}/4 - x/2, 2]*\sin[x]^{(3/2)})/21$

Rubi [A] time = 0.0375206, antiderivative size = 71, normalized size of antiderivative = 1., number of steps used = 5, number of rules used = 4, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.4$, Rules used = {4123, 3768, 3771, 2641}

$$-\frac{10}{21}a \cos(x) \sqrt{a \csc^3(x)} - \frac{2}{7}a \cot(x) \csc(x) \sqrt{a \csc^3(x)} - \frac{10}{21}a \sin^{\frac{3}{2}}(x) F\left(\frac{\pi}{4} - \frac{x}{2} \middle| 2\right) \sqrt{a \csc^3(x)}$$

Antiderivative was successfully verified.

[In] $\operatorname{Int}[(a*\csc[x]^3)^{(3/2)}, x]$

[Out] $(-10*a*\cos[x]*\operatorname{Sqrt}[a*\csc[x]^3])/21 - (2*a*\cot[x]*\csc[x]*\operatorname{Sqrt}[a*\csc[x]^3])/7 - (10*a*\operatorname{Sqrt}[a*\csc[x]^3]*\operatorname{EllipticF}[\text{Pi}/4 - x/2, 2]*\sin[x]^{(3/2)})/21$

Rule 4123

$\operatorname{Int}[(b_.)*((c_.)*\sec[(e_.) + (f_.)*(x_.)])^{(n_.)})^{(p_.)}, x_Symbol] \rightarrow \operatorname{Dist}[(b^{(n_)} \operatorname{IntPart}[p] * (b*(c*\sec[e + f*x])^n)^{\operatorname{FracPart}[p]} / (c*\sec[e + f*x])^{(n*\operatorname{FracPart}[p])}], \operatorname{Int}[(c*\sec[e + f*x])^{(n*p)}, x], x] /;$ FreeQ[{b, c, e, f, n, p}, x] && !IntegerQ[p]

Rule 3768

$\operatorname{Int}[(\csc[(c_.) + (d_.)*(x_.)]*(b_.))^{(n_.)}, x_Symbol] \rightarrow -\operatorname{Simp}[(b*\cos[c + d*x] * (b*\csc[c + d*x])^{(n-1)}) / (d*(n-1)), x] + \operatorname{Dist}[(b^{(n-2)}) / (n-1), \operatorname{Int}[(b*\csc[c + d*x])^{(n-2)}, x], x] /;$ FreeQ[{b, c, d}, x] && GtQ[n, 1] && IntegerQ[2*n]

Rule 3771

$\operatorname{Int}[(\csc[(c_.) + (d_.)*(x_.)]*(b_.))^{(n_.)}, x_Symbol] \rightarrow \operatorname{Dist}[(b*\csc[c + d*x])^{(n-1)} * \sin[c + d*x]^n, \operatorname{Int}[1/\sin[c + d*x]^n, x], x] /;$ FreeQ[{b, c, d}, x] &&

EqQ[n^2, 1/4]

Rule 2641

```
Int[1/Sqrt[sin[(c_.) + (d_.)*(x_)]], x_Symbol] :> Simp[(2*EllipticF[(1*(c - Pi/2 + d*x))/2, 2])/d, x] /; FreeQ[{c, d}, x]
```

Rubi steps

$$\begin{aligned}
\int (a \csc^3(x))^{3/2} dx &= -\frac{(a\sqrt{a \csc^3(x)}) \int (-\csc(x))^{9/2} dx}{(-\csc(x))^{3/2}} \\
&= -\frac{2}{7}a \cot(x) \csc(x) \sqrt{a \csc^3(x)} - \frac{(5a\sqrt{a \csc^3(x)}) \int (-\csc(x))^{5/2} dx}{7(-\csc(x))^{3/2}} \\
&= -\frac{10}{21}a \cos(x) \sqrt{a \csc^3(x)} - \frac{2}{7}a \cot(x) \csc(x) \sqrt{a \csc^3(x)} - \frac{(5a\sqrt{a \csc^3(x)}) \int \sqrt{-\csc(x)} dx}{21(-\csc(x))^{3/2}} \\
&= -\frac{10}{21}a \cos(x) \sqrt{a \csc^3(x)} - \frac{2}{7}a \cot(x) \csc(x) \sqrt{a \csc^3(x)} + \frac{1}{21} \left(5a\sqrt{a \csc^3(x)} \sin^{\frac{3}{2}}(x)\right) \int \frac{1}{\sqrt{\sin(x)}} dx \\
&= -\frac{10}{21}a \cos(x) \sqrt{a \csc^3(x)} - \frac{2}{7}a \cot(x) \csc(x) \sqrt{a \csc^3(x)} - \frac{10}{21}a\sqrt{a \csc^3(x)} F\left(\frac{\pi}{4} - \frac{x}{2} \middle| 2\right) \sin^{\frac{3}{2}}(x)
\end{aligned}$$

Mathematica [A] time = 0.113459, size = 46, normalized size = 0.65

$$-\frac{1}{84} (a \csc^3(x))^{3/2} \left(40 \sin^{\frac{9}{2}}(x) \text{EllipticF}\left(\frac{1}{4}(\pi - 2x), 2\right) + 22 \sin(2x) - 5 \sin(4x)\right)$$

Antiderivative was successfully verified.

[In] Integrate[(a*Csc[x]^3)^(3/2), x]

```
[Out] -((a*Csc[x]^3)^(3/2)*(40*EllipticF[(Pi - 2*x)/4, 2]*Sin[x]^(9/2) + 22*Sin[2*x] - 5*Sin[4*x]))/84
```

Maple [C] time = 0.319, size = 372, normalized size = 5.2

result too large to display

Verification of antiderivative is not currently implemented for this CAS.

[In] int((a*csc(x)^3)^(3/2),x)

[Out]
$$-1/168*8^{(1/2)}*(\cos(x)+1)^2*(-1+\cos(x))^2*(5*I*\sin(x)*\cos(x)^3*\text{EllipticF}(((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)},1/2*2^{(1/2)}))*((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}*((-I*\cos(x)+\sin(x)+I)/\sin(x))^{(1/2)}*(-I*(-1+\cos(x))/\sin(x))^{(1/2)}*2^{(1/2)}+5*I*\sin(x)*\cos(x)^2*\text{EllipticF}(((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)},1/2*2^{(1/2)}))*((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}*((-I*\cos(x)+\sin(x)+I)/\sin(x))^{(1/2)}*(-I*(-1+\cos(x))/\sin(x))^{(1/2)}*2^{(1/2)}-5*I*\sin(x)*\cos(x)*\text{EllipticF}(((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)},1/2*2^{(1/2)}))*((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}*((-I*\cos(x)+\sin(x)+I)/\sin(x))^{(1/2)}*(-I*(-1+\cos(x))/\sin(x))^{(1/2)}*2^{(1/2)}-5*I*((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}*2^{(1/2)}*((-I*\cos(x)+\sin(x)+I)/\sin(x))^{(1/2)}*(-I*(-1+\cos(x))/\sin(x))^{(1/2)}*\text{EllipticF}(((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)},1/2*2^{(1/2)}))*\sin(x)-10*\cos(x)^3+16*\cos(x))*(-2*a/\sin(x)/(\cos(x)^2-1))^{(3/2)}/\sin(x)^3$$

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int (a \csc(x)^3)^{\frac{3}{2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^3)^(3/2),x, algorithm="maxima")

[Out] integrate((a*csc(x)^3)^(3/2), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\sqrt{a \csc(x)^3} a \csc(x)^3, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^3)^(3/2),x, algorithm="fricas")

[Out] integral(sqrt(a*csc(x)^3)*a*csc(x)^3, x)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int (a \csc^3(x))^{\frac{3}{2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)**3)**(3/2), x)

[Out] Integral((a*csc(x)**3)**(3/2), x)

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int (a \csc(x)^3)^{\frac{3}{2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^3)^(3/2), x, algorithm="giac")

[Out] integrate((a*csc(x)^3)^(3/2), x)

3.57 $\int \sqrt{a \csc^3(x)} dx$

Optimal. Leaf size=48

$$2 \sin^{\frac{3}{2}}(x) E\left(\frac{\pi}{4} - \frac{x}{2} \middle| 2\right) \sqrt{a \csc^3(x)} - 2 \sin(x) \cos(x) \sqrt{a \csc^3(x)}$$

[Out] -2*Cos[x]*Sqrt[a*Csc[x]^3]*Sin[x] + 2*Sqrt[a*Csc[x]^3]*EllipticE[Pi/4 - x/2, 2]*Sin[x]^(3/2)

Rubi [A] time = 0.0270866, antiderivative size = 48, normalized size of antiderivative = 1., number of steps used = 4, number of rules used = 4, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.4$, Rules used = {4123, 3768, 3771, 2639}

$$2 \sin^{\frac{3}{2}}(x) E\left(\frac{\pi}{4} - \frac{x}{2} \middle| 2\right) \sqrt{a \csc^3(x)} - 2 \sin(x) \cos(x) \sqrt{a \csc^3(x)}$$

Antiderivative was successfully verified.

[In] Int[Sqrt[a*Csc[x]^3], x]

[Out] -2*Cos[x]*Sqrt[a*Csc[x]^3]*Sin[x] + 2*Sqrt[a*Csc[x]^3]*EllipticE[Pi/4 - x/2, 2]*Sin[x]^(3/2)

Rule 4123

Int[((b_.)*((c_.)*sec[(e_.) + (f_.)*(x_)])^(n_))^(p_), x_Symbol] := Dist[(b ^IntPart[p]*(b*(c*Sec[e + f*x])^n)^FracPart[p])/(c*Sec[e + f*x])^(n*FracPart[p]), Int[(c*Sec[e + f*x])^(n*p), x], x] /; FreeQ[{b, c, e, f, n, p}, x] && !IntegerQ[p]

Rule 3768

Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := -Simp[(b*Cos[c + d*x] *(b*Csc[c + d*x])^(n - 1))/(d*(n - 1)), x] + Dist[(b^2*(n - 2))/(n - 1), Int[(b*Csc[c + d*x])^(n - 2), x], x] /; FreeQ[{b, c, d}, x] && GtQ[n, 1] && IntegerQ[2*n]

Rule 3771

Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Dist[(b*Csc[c + d*x])^n*Sin[c + d*x]^n, Int[1/Sin[c + d*x]^n, x], x] /; FreeQ[{b, c, d}, x] &&

EqQ[n^2, 1/4]

Rule 2639

```
Int[Sqrt[sin[(c_.) + (d_.)*(x_)]], x_Symbol] :> Simp[(2*EllipticE[(1*(c - P
i/2 + d*x))/2, 2])/d, x] /; FreeQ[{c, d}, x]
```

Rubi steps

$$\begin{aligned}
\int \sqrt{a \csc^3(x)} dx &= \frac{\sqrt{a \csc^3(x)} \int (-\csc(x))^{3/2} dx}{(-\csc(x))^{3/2}} \\
&= -2 \cos(x) \sqrt{a \csc^3(x)} \sin(x) - \frac{\sqrt{a \csc^3(x)} \int \frac{1}{\sqrt{-\csc(x)}} dx}{(-\csc(x))^{3/2}} \\
&= -2 \cos(x) \sqrt{a \csc^3(x)} \sin(x) - \left(\sqrt{a \csc^3(x)} \sin^2(x) \right) \int \sqrt{\sin(x)} dx \\
&= -2 \cos(x) \sqrt{a \csc^3(x)} \sin(x) + 2 \sqrt{a \csc^3(x)} E \left(\frac{\pi}{4} - \frac{x}{2} \middle| 2 \right) \sin^{\frac{3}{2}}(x)
\end{aligned}$$

Mathematica [A] time = 0.0410909, size = 46, normalized size = 0.96

$$2 \sin^{\frac{3}{2}}(x) E \left(\frac{1}{4}(\pi - 2x) \middle| 2 \right) \sqrt{a \csc^3(x)} - 2 \sin(x) \cos(x) \sqrt{a \csc^3(x)}$$

Antiderivative was successfully verified.

[In] Integrate[Sqrt[a*Csc[x]^3], x]

```
[Out] -2*Cos[x]*Sqrt[a*Csc[x]^3]*Sin[x] + 2*Sqrt[a*Csc[x]^3]*EllipticE[(Pi - 2*x)
/4, 2]*Sin[x]^(3/2)
```

Maple [C] time = 0.278, size = 343, normalized size = 7.2

$$\frac{\sqrt{8} \sin(x)}{4} \left(2 \cos(x) \sqrt{\frac{-i(-1 + \cos(x))}{\sin(x)}} \sqrt{2} \sqrt{\frac{i \cos(x) + \sin(x) - i}{\sin(x)}} \sqrt{\frac{i \cos(x) - \sin(x) - i}{\sin(x)}} \text{EllipticE} \left(\sqrt{\frac{i \cos(x) + \sin(x) - i}{\sin(x)}} \right) \right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `int((a*csc(x)^3)^(1/2),x)`

[Out] $\frac{1}{4} \cdot 8^{1/2} \cdot (2 \cos(x) \cdot (-1 \cdot (-1 + \cos(x)) / \sin(x))^{1/2} \cdot 2^{1/2} \cdot ((I \cos(x) + \sin(x) - I) / \sin(x))^{1/2} \cdot (- (I \cos(x) - \sin(x) - I) / \sin(x))^{1/2} \cdot \text{EllipticE}(((I \cos(x) + \sin(x) - I) / \sin(x))^{1/2}, 1/2 \cdot 2^{1/2}) - \cos(x) \cdot (-1 \cdot (-1 + \cos(x)) / \sin(x))^{1/2} \cdot 2^{1/2} \cdot ((I \cos(x) + \sin(x) - I) / \sin(x))^{1/2} \cdot (- (I \cos(x) - \sin(x) - I) / \sin(x))^{1/2} \cdot \text{EllipticF}(((I \cos(x) + \sin(x) - I) / \sin(x))^{1/2}, 1/2 \cdot 2^{1/2}) + 2 \cdot (-1 \cdot (-1 + \cos(x)) / \sin(x))^{1/2} \cdot 2^{1/2} \cdot ((I \cos(x) + \sin(x) - I) / \sin(x))^{1/2} \cdot (- (I \cos(x) - \sin(x) - I) / \sin(x))^{1/2} \cdot \text{EllipticE}(((I \cos(x) + \sin(x) - I) / \sin(x))^{1/2}, 1/2 \cdot 2^{1/2}) - (-1 \cdot (-1 + \cos(x)) / \sin(x))^{1/2} \cdot 2^{1/2} \cdot ((I \cos(x) + \sin(x) - I) / \sin(x))^{1/2} \cdot (- (I \cos(x) - \sin(x) - I) / \sin(x))^{1/2} \cdot \text{EllipticF}(((I \cos(x) + \sin(x) - I) / \sin(x))^{1/2}, 1/2 \cdot 2^{1/2}) - 2) \cdot \sin(x) \cdot (-2 \cdot a / \sin(x) / (\cos(x)^2 - 1))^{1/2}$

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \sqrt{a \csc(x)^3} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate((a*csc(x)^3)^(1/2),x, algorithm="maxima")`

[Out] `integrate(sqrt(a*csc(x)^3), x)`

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\sqrt{a \csc(x)^3}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate((a*csc(x)^3)^(1/2),x, algorithm="fricas")`

[Out] `integral(sqrt(a*csc(x)^3), x)`

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \sqrt{a \csc^3(x)} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate((a*csc(x)**3)**(1/2),x)
```

```
[Out] Integral(sqrt(a*csc(x)**3), x)
```

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \sqrt{a \csc(x)^3} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate((a*csc(x)^3)^(1/2),x, algorithm="giac")
```

```
[Out] integrate(sqrt(a*csc(x)^3), x)
```

$$3.58 \quad \int \frac{1}{\sqrt{a \csc^3(x)}} dx$$

Optimal. Leaf size=50

$$-\frac{2\text{EllipticF}\left(\frac{\pi}{4} - \frac{x}{2}, 2\right)}{3\sin^{\frac{3}{2}}(x)\sqrt{a \csc^3(x)}} - \frac{2 \cot(x)}{3\sqrt{a \csc^3(x)}}$$

[Out] (-2*Cot[x])/(3*Sqrt[a*Csc[x]^3]) - (2*EllipticF[Pi/4 - x/2, 2])/(3*Sqrt[a*Csc[x]^3]*Sin[x]^(3/2))

Rubi [A] time = 0.0296832, antiderivative size = 50, normalized size of antiderivative = 1., number of steps used = 4, number of rules used = 4, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.4$, Rules used = {4123, 3769, 3771, 2641}

$$-\frac{2 \cot(x)}{3\sqrt{a \csc^3(x)}} - \frac{2F\left(\frac{\pi}{4} - \frac{x}{2} \middle| 2\right)}{3\sin^{\frac{3}{2}}(x)\sqrt{a \csc^3(x)}}$$

Antiderivative was successfully verified.

[In] Int[1/Sqrt[a*Csc[x]^3], x]

[Out] (-2*Cot[x])/(3*Sqrt[a*Csc[x]^3]) - (2*EllipticF[Pi/4 - x/2, 2])/(3*Sqrt[a*Csc[x]^3]*Sin[x]^(3/2))

Rule 4123

Int[((b_.)*((c_.)*sec[(e_.) + (f_.)*(x_)])^(n_))^(p_), x_Symbol] :> Dist[(b ^IntPart[p]*(b*(c*Sec[e + f*x])^n)^FracPart[p])/(c*Sec[e + f*x])^(n*FracPart[p]), Int[(c*Sec[e + f*x])^(n*p), x], x] /; FreeQ[{b, c, e, f, n, p}, x] & !IntegerQ[p]

Rule 3769

Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] :> Simp[(Cos[c + d*x]*(b*Csc[c + d*x])^(n + 1))/(b*d*n), x] + Dist[(n + 1)/(b^2*n), Int[(b*Csc[c + d*x])^(n + 2), x], x] /; FreeQ[{b, c, d}, x] && LtQ[n, -1] && IntegerQ[2*n]

Rule 3771


```
Int[(csc[(c_.) + (d_.)*(x_.)]*(b_.))^(n_.), x_Symbol] := Dist[(b*Csc[c + d*x]
)^(n)*Sin[c + d*x]^n, Int[1/Sin[c + d*x]^n, x], x] /; FreeQ[{b, c, d}, x] &&
EqQ[n^2, 1/4]
```

Rule 2641

```
Int[1/Sqrt[sin[(c_.) + (d_.)*(x_.)]], x_Symbol] := Simp[(2*EllipticF[(1*(c -
Pi/2 + d*x))/2, 2])/d, x] /; FreeQ[{c, d}, x]
```

Rubi steps

$$\begin{aligned}
 \int \frac{1}{\sqrt{a \csc^3(x)}} dx &= \frac{(-\csc(x))^{3/2} \int \frac{1}{(-\csc(x))^{3/2}} dx}{\sqrt{a \csc^3(x)}} \\
 &= -\frac{2 \cot(x)}{3\sqrt{a \csc^3(x)}} + \frac{(-\csc(x))^{3/2} \int \sqrt{-\csc(x)} dx}{3\sqrt{a \csc^3(x)}} \\
 &= -\frac{2 \cot(x)}{3\sqrt{a \csc^3(x)}} + \frac{\int \frac{1}{\sqrt{\sin(x)}} dx}{3\sqrt{a \csc^3(x)} \sin^{\frac{3}{2}}(x)} \\
 &= -\frac{2 \cot(x)}{3\sqrt{a \csc^3(x)}} - \frac{2F\left(\frac{\pi}{4} - \frac{x}{2} \middle| 2\right)}{3\sqrt{a \csc^3(x)} \sin^{\frac{3}{2}}(x)}
 \end{aligned}$$

Mathematica [A] time = 0.0490962, size = 38, normalized size = 0.76

$$\frac{-\frac{2\text{EllipticF}\left(\frac{1}{4}(\pi-2x),2\right)}{\sin^{\frac{3}{2}}(x)} - 2 \cot(x)}{3\sqrt{a \csc^3(x)}}$$

Antiderivative was successfully verified.

```
[In] Integrate[1/Sqrt[a*Csc[x]^3], x]
```

```
[Out] (-2*Cot[x] - (2*EllipticF[(Pi - 2*x)/4, 2])/Sin[x]^(3/2))/(3*Sqrt[a*Csc[x]^
3])
```

Maple [C] time = 0.25, size = 125, normalized size = 2.5

$$-\frac{\sqrt{8}}{(-6 + 6 \cos(x)) \sin(x)} \left(i \sin(x) \sqrt{\frac{-i(-1 + \cos(x))}{\sin(x)}} \sqrt{2} \sqrt{\frac{i \cos(x) - \sin(x) - i}{\sin(x)}} \operatorname{EllipticF} \left(\sqrt{\frac{i \cos(x) + \sin(x) - i}{\sin(x)}}, \frac{\sqrt{2}}{2} \right) \right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(1/(a*csc(x)^3)^(1/2),x)

[Out] -1/6*8^(1/2)*(I*sin(x)*(-I*(-1+cos(x))/sin(x))^(1/2)*2^(1/2)*(-(I*cos(x)-sin(x)-I)/sin(x))^(1/2)*EllipticF(((I*cos(x)+sin(x)-I)/sin(x))^(1/2),1/2*2^(1/2))*((I*cos(x)+sin(x)-I)/sin(x))^(1/2)+2*cos(x)^2-2*cos(x))/(-1+cos(x))/(-2*a/sin(x)/(cos(x)^2-1))^(1/2)/sin(x)

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\sqrt{a \csc(x)^3}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(a*csc(x)^3)^(1/2),x, algorithm="maxima")

[Out] integrate(1/sqrt(a*csc(x)^3), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\operatorname{integral} \left(\frac{\sqrt{a \csc(x)^3}}{a \csc(x)^3}, x \right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(a*csc(x)^3)^(1/2),x, algorithm="fricas")

[Out] integral(sqrt(a*csc(x)^3)/(a*csc(x)^3), x)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\sqrt{a \csc^3(x)}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(a*csc(x)**3)**(1/2),x)

[Out] Integral(1/sqrt(a*csc(x)**3), x)

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\sqrt{a \csc(x)^3}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(a*csc(x)^3)^(1/2),x, algorithm="giac")

[Out] integrate(1/sqrt(a*csc(x)^3), x)

$$3.59 \quad \int \frac{1}{(a \csc^3(x))^{3/2}} dx$$

Optimal. Leaf size=79

$$-\frac{14 \cos(x)}{45a\sqrt{a \csc^3(x)}} - \frac{2 \sin^2(x) \cos(x)}{9a\sqrt{a \csc^3(x)}} - \frac{14E\left(\frac{\pi}{4} - \frac{x}{2} \middle| 2\right)}{15a \sin^{\frac{3}{2}}(x)\sqrt{a \csc^3(x)}}$$

[Out] (-14*Cos[x])/(45*a*Sqrt[a*Csc[x]^3]) - (14*EllipticE[Pi/4 - x/2, 2])/(15*a*Sqrt[a*Csc[x]^3]*Sin[x]^(3/2)) - (2*Cos[x]*Sin[x]^2)/(9*a*Sqrt[a*Csc[x]^3])

Rubi [A] time = 0.0383605, antiderivative size = 79, normalized size of antiderivative = 1., number of steps used = 5, number of rules used = 4, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.4$, Rules used = {4123, 3769, 3771, 2639}

$$-\frac{14 \cos(x)}{45a\sqrt{a \csc^3(x)}} - \frac{2 \sin^2(x) \cos(x)}{9a\sqrt{a \csc^3(x)}} - \frac{14E\left(\frac{\pi}{4} - \frac{x}{2} \middle| 2\right)}{15a \sin^{\frac{3}{2}}(x)\sqrt{a \csc^3(x)}}$$

Antiderivative was successfully verified.

[In] Int[(a*Csc[x]^3)^(-3/2), x]

[Out] (-14*Cos[x])/(45*a*Sqrt[a*Csc[x]^3]) - (14*EllipticE[Pi/4 - x/2, 2])/(15*a*Sqrt[a*Csc[x]^3]*Sin[x]^(3/2)) - (2*Cos[x]*Sin[x]^2)/(9*a*Sqrt[a*Csc[x]^3])

Rule 4123

Int[((b_.)*((c_.)*sec[(e_.) + (f_.)*(x_)])^(n_.))^(p_), x_Symbol] := Dist[(b ^IntPart[p]*(b*(c*Sec[e + f*x])^n)^FracPart[p])/(c*Sec[e + f*x])^(n*FracPart[p]), Int[(c*Sec[e + f*x])^(n*p), x], x] /; FreeQ[{b, c, e, f, n, p}, x] & !IntegerQ[p]

Rule 3769

Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Simp[(Cos[c + d*x]*(b*Csc[c + d*x])^(n + 1))/(b*d*n), x] + Dist[(n + 1)/(b^2*n), Int[(b*Csc[c + d*x])^(n + 2), x], x] /; FreeQ[{b, c, d}, x] && LtQ[n, -1] && IntegerQ[2*n]

Rule 3771

```
Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Dist[(b*Csc[c + d*x]
)^(n)*Sin[c + d*x]^n, Int[1/Sin[c + d*x]^n, x], x] /; FreeQ[{b, c, d}, x] &&
EqQ[n^2, 1/4]
```

Rule 2639

```
Int[Sqrt[sin[(c_.) + (d_.)*(x_)]], x_Symbol] := Simp[(2*EllipticE[(1*(c - P
i/2 + d*x))/2, 2])/d, x] /; FreeQ[{c, d}, x]
```

Rubi steps

$$\begin{aligned}
\int \frac{1}{(a \csc^3(x))^{3/2}} dx &= -\frac{(-\csc(x))^{3/2} \int \frac{1}{(-\csc(x))^{9/2}} dx}{a\sqrt{a} \csc^3(x)} \\
&= -\frac{2 \cos(x) \sin^2(x)}{9a\sqrt{a} \csc^3(x)} - \frac{(7(-\csc(x))^{3/2}) \int \frac{1}{(-\csc(x))^{5/2}} dx}{9a\sqrt{a} \csc^3(x)} \\
&= -\frac{14 \cos(x)}{45a\sqrt{a} \csc^3(x)} - \frac{2 \cos(x) \sin^2(x)}{9a\sqrt{a} \csc^3(x)} - \frac{(7(-\csc(x))^{3/2}) \int \frac{1}{\sqrt{-\csc(x)}} dx}{15a\sqrt{a} \csc^3(x)} \\
&= -\frac{14 \cos(x)}{45a\sqrt{a} \csc^3(x)} - \frac{2 \cos(x) \sin^2(x)}{9a\sqrt{a} \csc^3(x)} + \frac{7 \int \sqrt{\sin(x)} dx}{15a\sqrt{a} \csc^3(x) \sin^{\frac{3}{2}}(x)} \\
&= -\frac{14 \cos(x)}{45a\sqrt{a} \csc^3(x)} - \frac{14E\left(\frac{\pi}{4} - \frac{x}{2} \middle| 2\right)}{15a\sqrt{a} \csc^3(x) \sin^{\frac{3}{2}}(x)} - \frac{2 \cos(x) \sin^2(x)}{9a\sqrt{a} \csc^3(x)}
\end{aligned}$$

Mathematica [A] time = 0.0954014, size = 52, normalized size = 0.66

$$\frac{\sin^{\frac{3}{2}}(x)(5 \cos(3x) - 33 \cos(x)) - 84E\left(\frac{1}{4}(\pi - 2x) \middle| 2\right)}{90 \sin^{\frac{9}{2}}(x) (a \csc^3(x))^{3/2}}$$

Antiderivative was successfully verified.

```
[In] Integrate[(a*Csc[x]^3)^(-3/2), x]
```

```
[Out] (-84*EllipticE[(Pi - 2*x)/4, 2] + (-33*Cos[x] + 5*Cos[3*x])*Sin[x]^(3/2))/(
90*(a*Csc[x]^3)^(3/2)*Sin[x]^(9/2))
```

Maple [C] time = 0.235, size = 349, normalized size = 4.4

result too large to display

Verification of antiderivative is not currently implemented for this CAS.

[In] `int(1/(a*csc(x)^3)^(3/2),x)`

[Out]
$$-1/45*8^{(1/2)}*(42*\cos(x)*2^{(1/2)}*(-I*(-1+\cos(x))/\sin(x))^{(1/2)}*((-I*\cos(x)+\sin(x)+I)/\sin(x))^{(1/2)}*\text{EllipticE}(((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)},1/2*2^{(1/2)})*((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}-21*\cos(x)*2^{(1/2)}*(-I*(-1+\cos(x))/\sin(x))^{(1/2)}*((-I*\cos(x)+\sin(x)+I)/\sin(x))^{(1/2)}*((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}*\text{EllipticF}(((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)},1/2*2^{(1/2)})+10*\cos(x)^5+42*2^{(1/2)}*(-I*(-1+\cos(x))/\sin(x))^{(1/2)}*((-I*\cos(x)+\sin(x)+I)/\sin(x))^{(1/2)}*\text{EllipticE}(((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)},1/2*2^{(1/2)})*((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}-21*2^{(1/2)}*(-I*(-1+\cos(x))/\sin(x))^{(1/2)}*((-I*\cos(x)+\sin(x)+I)/\sin(x))^{(1/2)}*((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)}*\text{EllipticF}(((I*\cos(x)+\sin(x)-I)/\sin(x))^{(1/2)},1/2*2^{(1/2)})-34*\cos(x)^3+66*\cos(x)-42)/(-2*a/\sin(x)/(\cos(x)^2-1))^{(3/2)}/\sin(x)^5$$

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(a \csc(x)^3)^{3/2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(a*csc(x)^3)^(3/2),x, algorithm="maxima")`

[Out] `integrate((a*csc(x)^3)^(-3/2), x)`

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\frac{\sqrt{a \csc(x)^3}}{a^2 \csc(x)^6}, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/(a*csc(x)^3)^(3/2),x, algorithm="fricas")
```

```
[Out] integral(sqrt(a*csc(x)^3)/(a^2*csc(x)^6), x)
```

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(a \csc^3(x))^{\frac{3}{2}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/(a*csc(x)**3)**(3/2),x)
```

```
[Out] Integral((a*csc(x)**3)**(-3/2), x)
```

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(a \csc(x)^3)^{\frac{3}{2}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/(a*csc(x)^3)^(3/2),x, algorithm="giac")
```

```
[Out] integrate((a*csc(x)^3)^(-3/2), x)
```

$$3.60 \quad \int \frac{1}{(a \csc^3(x))^{5/2}} dx$$

Optimal. Leaf size=123

$$-\frac{26 \operatorname{EllipticF}\left(\frac{\pi}{4} - \frac{x}{2}, 2\right)}{77a^2 \sin^{\frac{3}{2}}(x) \sqrt{a \csc^3(x)}} - \frac{26 \cot(x)}{77a^2 \sqrt{a \csc^3(x)}} - \frac{2 \sin^5(x) \cos(x)}{15a^2 \sqrt{a \csc^3(x)}} - \frac{26 \sin^3(x) \cos(x)}{165a^2 \sqrt{a \csc^3(x)}} - \frac{78 \sin(x) \cos(x)}{385a^2 \sqrt{a \csc^3(x)}}$$

[Out] (-26*Cot[x])/((77*a^2*Sqrt[a*Csc[x]^3]) - (26*EllipticF[Pi/4 - x/2, 2])/((77*a^2*Sqrt[a*Csc[x]^3]*Sin[x]^(3/2)) - (78*Cos[x]*Sin[x])/(385*a^2*Sqrt[a*Csc[x]^3]) - (26*Cos[x]*Sin[x]^3)/(165*a^2*Sqrt[a*Csc[x]^3]) - (2*Cos[x]*Sin[x]^5)/(15*a^2*Sqrt[a*Csc[x]^3]))

Rubi [A] time = 0.0611232, antiderivative size = 123, normalized size of antiderivative = 1., number of steps used = 7, number of rules used = 4, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.4$, Rules used = {4123, 3769, 3771, 2641}

$$-\frac{26 \cot(x)}{77a^2 \sqrt{a \csc^3(x)}} - \frac{2 \sin^5(x) \cos(x)}{15a^2 \sqrt{a \csc^3(x)}} - \frac{26 \sin^3(x) \cos(x)}{165a^2 \sqrt{a \csc^3(x)}} - \frac{78 \sin(x) \cos(x)}{385a^2 \sqrt{a \csc^3(x)}} - \frac{26F\left(\frac{\pi}{4} - \frac{x}{2} \middle| 2\right)}{77a^2 \sin^{\frac{3}{2}}(x) \sqrt{a \csc^3(x)}}$$

Antiderivative was successfully verified.

[In] Int[(a*Csc[x]^3)^(-5/2), x]

[Out] (-26*Cot[x])/((77*a^2*Sqrt[a*Csc[x]^3]) - (26*EllipticF[Pi/4 - x/2, 2])/((77*a^2*Sqrt[a*Csc[x]^3]*Sin[x]^(3/2)) - (78*Cos[x]*Sin[x])/(385*a^2*Sqrt[a*Csc[x]^3]) - (26*Cos[x]*Sin[x]^3)/(165*a^2*Sqrt[a*Csc[x]^3]) - (2*Cos[x]*Sin[x]^5)/(15*a^2*Sqrt[a*Csc[x]^3]))

Rule 4123

Int[((b_.)*((c_.)*sec[(e_.) + (f_.)*(x_)])^(n_.))^(p_), x_Symbol] :> Dist[(b^IntPart[p]*(c*Sec[e + f*x])^n)^FracPart[p]]/(c*Sec[e + f*x])^(n*FracPart[p]), Int[(c*Sec[e + f*x])^(n*p), x], x] /; FreeQ[{b, c, e, f, n, p}, x] && !IntegerQ[p]

Rule 3769

Int[(csc[(c_.) + (d_.)*(x_)])*(b_.))^(n_), x_Symbol] :> Simp[(Cos[c + d*x]*(b*Csc[c + d*x])^(n + 1))/(b*d*n), x] + Dist[(n + 1)/(b^2*n), Int[(b*Csc[c +

$d*x])^{(n + 2), x], x] /; \text{FreeQ}[\{b, c, d\}, x] \ \&\& \ \text{LtQ}[n, -1] \ \&\& \ \text{IntegerQ}[2*n]$

Rule 3771

$\text{Int}[(\text{csc}[c_.] + (d_.)*(x_.)]*(b_.))^{(n_.)}, x_Symbol] \ :> \ \text{Dist}[(b*\text{Csc}[c + d*x])^{n*} \ \text{Sin}[c + d*x]^n, \ \text{Int}[1/\text{Sin}[c + d*x]^n, x], x] /; \ \text{FreeQ}[\{b, c, d\}, x] \ \&\& \ \text{EqQ}[n^2, 1/4]$

Rule 2641

$\text{Int}[1/\text{Sqrt}[\text{sin}[c_.] + (d_.)*(x_.)]], x_Symbol] \ :> \ \text{Simp}[(2*\text{EllipticF}[(1*(c - \text{Pi}/2 + d*x))/2, 2])/d, x] /; \ \text{FreeQ}[\{c, d\}, x]$

Rubi steps

$$\begin{aligned}
 \int \frac{1}{(a \csc^3(x))^{5/2}} dx &= \frac{(-\csc(x))^{3/2} \int \frac{1}{(-\csc(x))^{15/2}} dx}{a^2 \sqrt{a \csc^3(x)}} \\
 &= -\frac{2 \cos(x) \sin^5(x)}{15a^2 \sqrt{a \csc^3(x)}} + \frac{(13(-\csc(x))^{3/2}) \int \frac{1}{(-\csc(x))^{11/2}} dx}{15a^2 \sqrt{a \csc^3(x)}} \\
 &= -\frac{26 \cos(x) \sin^3(x)}{165a^2 \sqrt{a \csc^3(x)}} - \frac{2 \cos(x) \sin^5(x)}{15a^2 \sqrt{a \csc^3(x)}} + \frac{(39(-\csc(x))^{3/2}) \int \frac{1}{(-\csc(x))^{7/2}} dx}{55a^2 \sqrt{a \csc^3(x)}} \\
 &= -\frac{78 \cos(x) \sin(x)}{385a^2 \sqrt{a \csc^3(x)}} - \frac{26 \cos(x) \sin^3(x)}{165a^2 \sqrt{a \csc^3(x)}} - \frac{2 \cos(x) \sin^5(x)}{15a^2 \sqrt{a \csc^3(x)}} + \frac{(39(-\csc(x))^{3/2}) \int \frac{1}{(-\csc(x))^{3/2}} dx}{77a^2 \sqrt{a \csc^3(x)}} \\
 &= -\frac{26 \cot(x)}{77a^2 \sqrt{a \csc^3(x)}} - \frac{78 \cos(x) \sin(x)}{385a^2 \sqrt{a \csc^3(x)}} - \frac{26 \cos(x) \sin^3(x)}{165a^2 \sqrt{a \csc^3(x)}} - \frac{2 \cos(x) \sin^5(x)}{15a^2 \sqrt{a \csc^3(x)}} + \frac{(13(-\csc(x))^{3/2}) \int \frac{1}{\sqrt{\sin(x)}} dx}{77a^2 \sqrt{a \csc^3(x)}} \\
 &= -\frac{26 \cot(x)}{77a^2 \sqrt{a \csc^3(x)}} - \frac{78 \cos(x) \sin(x)}{385a^2 \sqrt{a \csc^3(x)}} - \frac{26 \cos(x) \sin^3(x)}{165a^2 \sqrt{a \csc^3(x)}} - \frac{2 \cos(x) \sin^5(x)}{15a^2 \sqrt{a \csc^3(x)}} + \frac{13 \int \frac{1}{\sqrt{\sin(x)}} dx}{77a^2 \sqrt{a \csc^3(x)}} \\
 &= -\frac{26 \cot(x)}{77a^2 \sqrt{a \csc^3(x)}} - \frac{26F\left(\frac{\pi}{4} - \frac{x}{2}, 2\right)}{77a^2 \sqrt{a \csc^3(x)} \sin^{\frac{3}{2}}(x)} - \frac{78 \cos(x) \sin(x)}{385a^2 \sqrt{a \csc^3(x)}} - \frac{26 \cos(x) \sin^3(x)}{165a^2 \sqrt{a \csc^3(x)}} - \frac{2 \cos(x) \sin^5(x)}{15a^2 \sqrt{a \csc^3(x)}}
 \end{aligned}$$

Mathematica [A] time = 0.147149, size = 63, normalized size = 0.51

$$\frac{\sin(x) \sqrt{a \csc^3(x)} \left(24960 \sqrt{\sin(x)} \text{EllipticF}\left(\frac{1}{4}(\pi - 2x), 2\right) + 19122 \sin(2x) - 4406 \sin(4x) + 826 \sin(6x) - 77 \sin(8x) \right)}{73920a^3}$$

Antiderivative was successfully verified.

[In] Integrate[(a*Csc[x]^3)^(-5/2),x]

[Out] -(Sqrt[a*Csc[x]^3]*Sin[x]*(24960*EllipticF[(Pi - 2*x)/4, 2]*Sqrt[Sin[x]] + 19122*Sin[2*x] - 4406*Sin[4*x] + 826*Sin[6*x] - 77*Sin[8*x]))/(73920*a^3)

Maple [C] time = 0.264, size = 158, normalized size = 1.3

$$-\frac{2\sqrt{8}}{(-1155 + 1155 \cos(x))(\sin(x))^7} \left(-154 (\cos(x))^8 + 195 i\sqrt{2} \sin(x) \operatorname{EllipticF} \left(\sqrt{\frac{i \cos(x) + \sin(x) - i}{\sin(x)}}, \frac{\sqrt{2}}{2} \right) \sqrt{\frac{-i \cos(x) + \sin(x) + i}{\sin(x)}} \right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(1/(a*csc(x)^3)^(5/2),x)

[Out] -2/1155*8^(1/2)*(-154*cos(x)^8+195*I*2^(1/2)*sin(x)*EllipticF(((I*cos(x)+sin(x)-I)/sin(x))^(1/2),1/2*2^(1/2))*((-I*cos(x)+sin(x)+I)/sin(x))^(1/2))*((I*cos(x)+sin(x)-I)/sin(x))^(1/2)*(-I*(-1+cos(x))/sin(x))^(1/2)+154*cos(x)^7+644*cos(x)^6-644*cos(x)^5-1060*cos(x)^4+1060*cos(x)^3+960*cos(x)^2-960*cos(x))/(-1+cos(x))/(-2*a/sin(x)/(cos(x)^2-1))^(5/2)/sin(x)^7

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(a \csc(x)^3)^{\frac{5}{2}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(a*csc(x)^3)^(5/2),x, algorithm="maxima")

[Out] integrate((a*csc(x)^3)^(-5/2), x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral} \left(\frac{\sqrt{a \csc(x)^3}}{a^3 \csc(x)^9}, x \right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(a*csc(x)^3)^(5/2),x, algorithm="fricas")

[Out] integral(sqrt(a*csc(x)^3)/(a^3*csc(x)^9), x)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(a \csc^3(x))^{\frac{5}{2}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(a*csc(x)**3)**(5/2),x)

[Out] Integral((a*csc(x)**3)**(-5/2), x)

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(a \csc(x)^3)^{\frac{5}{2}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(a*csc(x)^3)^(5/2),x, algorithm="giac")

[Out] integrate((a*csc(x)^3)^(-5/2), x)

3.61 $\int \left(a \csc^4(x) \right)^{7/2} dx$

Optimal. Leaf size=164

$$-\frac{1}{13}a^3 \cos^2(x) \cot^{11}(x) \sqrt{a \csc^4(x)} - \frac{6}{11}a^3 \cos^2(x) \cot^9(x) \sqrt{a \csc^4(x)} - \frac{5}{3}a^3 \cos^2(x) \cot^7(x) \sqrt{a \csc^4(x)} - \frac{20}{7}a^3 \cos^2(x) \cot^5(x) \sqrt{a \csc^4(x)}$$

```
[Out] -2*a^3*Cos[x]^2*Cot[x]*Sqrt[a*Csc[x]^4] - 3*a^3*Cos[x]^2*Cot[x]^3*Sqrt[a*Csc[x]^4] - (20*a^3*Cos[x]^2*Cot[x]^5*Sqrt[a*Csc[x]^4])/7 - (5*a^3*Cos[x]^2*Cot[x]^7*Sqrt[a*Csc[x]^4])/3 - (6*a^3*Cos[x]^2*Cot[x]^9*Sqrt[a*Csc[x]^4])/11 - (a^3*Cos[x]^2*Cot[x]^11*Sqrt[a*Csc[x]^4])/13 - a^3*Cos[x]*Sqrt[a*Csc[x]^4]*Sin[x]
```

Rubi [A] time = 0.0352601, antiderivative size = 164, normalized size of antiderivative = 1., number of steps used = 3, number of rules used = 2, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.2$, Rules used = {4123, 3767}

$$-\frac{1}{13}a^3 \cos^2(x) \cot^{11}(x) \sqrt{a \csc^4(x)} - \frac{6}{11}a^3 \cos^2(x) \cot^9(x) \sqrt{a \csc^4(x)} - \frac{5}{3}a^3 \cos^2(x) \cot^7(x) \sqrt{a \csc^4(x)} - \frac{20}{7}a^3 \cos^2(x) \cot^5(x) \sqrt{a \csc^4(x)}$$

Antiderivative was successfully verified.

```
[In] Int[(a*Csc[x]^4)^(7/2), x]
```

```
[Out] -2*a^3*Cos[x]^2*Cot[x]*Sqrt[a*Csc[x]^4] - 3*a^3*Cos[x]^2*Cot[x]^3*Sqrt[a*Csc[x]^4] - (20*a^3*Cos[x]^2*Cot[x]^5*Sqrt[a*Csc[x]^4])/7 - (5*a^3*Cos[x]^2*Cot[x]^7*Sqrt[a*Csc[x]^4])/3 - (6*a^3*Cos[x]^2*Cot[x]^9*Sqrt[a*Csc[x]^4])/11 - (a^3*Cos[x]^2*Cot[x]^11*Sqrt[a*Csc[x]^4])/13 - a^3*Cos[x]*Sqrt[a*Csc[x]^4]*Sin[x]
```

Rule 4123

```
Int[((b_.)*((c_.)*sec[(e_.) + (f_.)*(x_)])^(n_))^(p_), x_Symbol] := Dist[(b^IntPart[p]*(c*(c*Sec[e + f*x])^n)^FracPart[p])/(c*Sec[e + f*x])^(n*FracPart[p]), Int[(c*Sec[e + f*x])^(n*p), x], x] /; FreeQ[{b, c, e, f, n, p}, x] && !IntegerQ[p]
```

Rule 3767

```
Int[csc[(c_.) + (d_.)*(x_)]^(n_), x_Symbol] := -Dist[d^(-1), Subst[Int[ExpandIntegrand[(1 + x^2)^(n/2 - 1), x], x], x, Cot[c + d*x]], x] /; FreeQ[{c,
```

d}, x] && IGtQ[n/2, 0]

Rubi steps

$$\begin{aligned} \int (a \csc^4(x))^{7/2} dx &= \left(a^3 \sqrt{a \csc^4(x) \sin^2(x)} \right) \int \csc^{14}(x) dx \\ &= - \left(\left(a^3 \sqrt{a \csc^4(x) \sin^2(x)} \right) \text{Subst} \left(\int (1 + 6x^2 + 15x^4 + 20x^6 + 15x^8 + 6x^{10} + x^{12}) dx, x, \cot(x) \right) \right) \\ &= -2a^3 \cos^2(x) \cot(x) \sqrt{a \csc^4(x)} - 3a^3 \cos^2(x) \cot^3(x) \sqrt{a \csc^4(x)} - \frac{20}{7} a^3 \cos^2(x) \cot^5(x) \sqrt{a \csc^4(x)} \end{aligned}$$

Mathematica [A] time = 0.0580877, size = 59, normalized size = 0.36

$$\frac{a^3 \sin(x) \cos(x) (231 \csc^{12}(x) + 252 \csc^{10}(x) + 280 \csc^8(x) + 320 \csc^6(x) + 384 \csc^4(x) + 512 \csc^2(x) + 1024) \sqrt{a \csc^4(x)}}{3003}$$

Antiderivative was successfully verified.

[In] Integrate[(a*Csc[x]^4)^(7/2), x]

[Out] -(a^3*Cos[x]*Sqrt[a*Csc[x]^4]*(1024 + 512*Csc[x]^2 + 384*Csc[x]^4 + 320*Csc[x]^6 + 280*Csc[x]^8 + 252*Csc[x]^10 + 231*Csc[x]^12)*Sin[x])/3003

Maple [A] time = 0.273, size = 53, normalized size = 0.3

$$\frac{(1024 (\cos(x))^{12} - 6656 (\cos(x))^{10} + 18304 (\cos(x))^8 - 27456 (\cos(x))^6 + 24024 (\cos(x))^4 - 12012 (\cos(x))^2 + 3003) \cos(x) \sin(x) \sqrt{a \csc^4(x)}}{3003}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int((a*csc(x)^4)^(7/2), x)

[Out] -1/3003*(1024*cos(x)^12-6656*cos(x)^10+18304*cos(x)^8-27456*cos(x)^6+24024*cos(x)^4-12012*cos(x)^2+3003)*cos(x)*sin(x)*(a/sin(x)^4)^(7/2)

Maxima [A] time = 1.50019, size = 89, normalized size = 0.54

$$\frac{3003 a^{\frac{7}{2}} \tan(x)^{12} + 6006 a^{\frac{7}{2}} \tan(x)^{10} + 9009 a^{\frac{7}{2}} \tan(x)^8 + 8580 a^{\frac{7}{2}} \tan(x)^6 + 5005 a^{\frac{7}{2}} \tan(x)^4 + 1638 a^{\frac{7}{2}} \tan(x)^2 + 231 a^{\frac{7}{2}}}{3003 \tan(x)^{13}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^4)^(7/2),x, algorithm="maxima")

[Out] -1/3003*(3003*a^(7/2)*tan(x)^12 + 6006*a^(7/2)*tan(x)^10 + 9009*a^(7/2)*tan(x)^8 + 8580*a^(7/2)*tan(x)^6 + 5005*a^(7/2)*tan(x)^4 + 1638*a^(7/2)*tan(x)^2 + 231*a^(7/2))/tan(x)^13

Fricas [A] time = 0.547037, size = 360, normalized size = 2.2

$$\frac{(1024 a^3 \cos(x)^{13} - 6656 a^3 \cos(x)^{11} + 18304 a^3 \cos(x)^9 - 27456 a^3 \cos(x)^7 + 24024 a^3 \cos(x)^5 - 12012 a^3 \cos(x)^3 + 3003 a^3 \cos(x)) \sqrt{a / (\cos(x)^4 - 2 \cos(x)^2 + 1)}}{3003 (\cos(x)^{10} - 5 \cos(x)^8 + 10 \cos(x)^6 - 10 \cos(x)^4 + 5 \cos(x)^2 - 1) \sin(x)}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^4)^(7/2),x, algorithm="fricas")

[Out] 1/3003*(1024*a^3*cos(x)^13 - 6656*a^3*cos(x)^11 + 18304*a^3*cos(x)^9 - 27456*a^3*cos(x)^7 + 24024*a^3*cos(x)^5 - 12012*a^3*cos(x)^3 + 3003*a^3*cos(x))*sqrt(a/(cos(x)^4 - 2*cos(x)^2 + 1))/((cos(x)^10 - 5*cos(x)^8 + 10*cos(x)^6 - 10*cos(x)^4 + 5*cos(x)^2 - 1)*sin(x))

Sympy [F(-1)] time = 0., size = 0, normalized size = 0.

Timed out

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)**4)**(7/2),x)

[Out] Timed out

Giac [A] time = 1.29849, size = 93, normalized size = 0.57

$$\frac{(3003 a^3 \tan(x)^{12} + 6006 a^3 \tan(x)^{10} + 9009 a^3 \tan(x)^8 + 8580 a^3 \tan(x)^6 + 5005 a^3 \tan(x)^4 + 1638 a^3 \tan(x)^2 + 231 a^3)}{3003 \tan(x)^{13}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^4)^(7/2),x, algorithm="giac")

[Out] -1/3003*(3003*a^3*tan(x)^12 + 6006*a^3*tan(x)^10 + 9009*a^3*tan(x)^8 + 8580*a^3*tan(x)^6 + 5005*a^3*tan(x)^4 + 1638*a^3*tan(x)^2 + 231*a^3)*sqrt(a)/tan(x)^13

3.62 $\int \left(a \csc^4(x) \right)^{5/2} dx$

Optimal. Leaf size=118

$$-\frac{1}{9}a^2 \cos^2(x) \cot^7(x) \sqrt{a \csc^4(x)} - \frac{4}{7}a^2 \cos^2(x) \cot^5(x) \sqrt{a \csc^4(x)} - \frac{6}{5}a^2 \cos^2(x) \cot^3(x) \sqrt{a \csc^4(x)} - \frac{4}{3}a^2 \cos^2(x) \cot(x) \sqrt{a \csc^4(x)}$$

[Out] $(-4*a^2*\cos[x]^2*\cot[x]*\sqrt{a*\csc[x]^4})/3 - (6*a^2*\cos[x]^2*\cot[x]^3*\sqrt{a*\csc[x]^4})/5 - (4*a^2*\cos[x]^2*\cot[x]^5*\sqrt{a*\csc[x]^4})/7 - (a^2*\cos[x]^2*\cot[x]^7*\sqrt{a*\csc[x]^4})/9 - a^2*\cos[x]*\sqrt{a*\csc[x]^4}*\sin[x]$

Rubi [A] time = 0.027743, antiderivative size = 118, normalized size of antiderivative = 1., number of steps used = 3, number of rules used = 2, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.2$, Rules used = {4123, 3767}

$$-\frac{1}{9}a^2 \cos^2(x) \cot^7(x) \sqrt{a \csc^4(x)} - \frac{4}{7}a^2 \cos^2(x) \cot^5(x) \sqrt{a \csc^4(x)} - \frac{6}{5}a^2 \cos^2(x) \cot^3(x) \sqrt{a \csc^4(x)} - \frac{4}{3}a^2 \cos^2(x) \cot(x) \sqrt{a \csc^4(x)}$$

Antiderivative was successfully verified.

[In] Int[(a*Csc[x]^4)^(5/2), x]

[Out] $(-4*a^2*\cos[x]^2*\cot[x]*\sqrt{a*\csc[x]^4})/3 - (6*a^2*\cos[x]^2*\cot[x]^3*\sqrt{a*\csc[x]^4})/5 - (4*a^2*\cos[x]^2*\cot[x]^5*\sqrt{a*\csc[x]^4})/7 - (a^2*\cos[x]^2*\cot[x]^7*\sqrt{a*\csc[x]^4})/9 - a^2*\cos[x]*\sqrt{a*\csc[x]^4}*\sin[x]$

Rule 4123

Int[((b_.)*((c_.)*sec[(e_.) + (f_.)*(x_)])^(n_))^(p_), x_Symbol] :> Dist[(b^IntPart[p]*(b*(c*Sec[e + f*x])^n)^FracPart[p])/(c*Sec[e + f*x])^(n*FracPart[p]), Int[(c*Sec[e + f*x])^(n*p), x], x] /; FreeQ[{b, c, e, f, n, p}, x] && !IntegerQ[p]

Rule 3767

Int[csc[(c_.) + (d_.)*(x_)]^(n_), x_Symbol] :> -Dist[d^(-1), Subst[Int[ExpandIntegrand[(1 + x^2)^(n/2 - 1), x], x], x, Cot[c + d*x]], x] /; FreeQ[{c, d}, x] && IGtQ[n/2, 0]

Rubi steps

$$\begin{aligned}
\int (a \csc^4(x))^{5/2} dx &= \left(a^2 \sqrt{a \csc^4(x) \sin^2(x)} \right) \int \csc^{10}(x) dx \\
&= - \left(\left(a^2 \sqrt{a \csc^4(x) \sin^2(x)} \right) \text{Subst} \left(\int (1 + 4x^2 + 6x^4 + 4x^6 + x^8) dx, x, \cot(x) \right) \right) \\
&= -\frac{4}{3} a^2 \cos^2(x) \cot(x) \sqrt{a \csc^4(x)} - \frac{6}{5} a^2 \cos^2(x) \cot^3(x) \sqrt{a \csc^4(x)} - \frac{4}{7} a^2 \cos^2(x) \cot^5(x) \sqrt{a \csc^4(x)}
\end{aligned}$$

Mathematica [A] time = 0.0359674, size = 47, normalized size = 0.4

$$-\frac{1}{315} a^2 \sin(x) \cos(x) (35 \csc^8(x) + 40 \csc^6(x) + 48 \csc^4(x) + 64 \csc^2(x) + 128) \sqrt{a \csc^4(x)}$$

Antiderivative was successfully verified.

[In] Integrate[(a*Csc[x]^4)^(5/2), x]

[Out] -(a^2*Cos[x]*Sqrt[a*Csc[x]^4]*(128 + 64*Csc[x]^2 + 48*Csc[x]^4 + 40*Csc[x]^6 + 35*Csc[x]^8)*Sin[x])/315

Maple [A] time = 0.175, size = 41, normalized size = 0.4

$$\frac{(128 (\cos(x))^8 - 576 (\cos(x))^6 + 1008 (\cos(x))^4 - 840 (\cos(x))^2 + 315) \cos(x) \sin(x)}{315} \left(\frac{a}{(\sin(x))^4} \right)^{\frac{5}{2}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int((a*csc(x)^4)^(5/2), x)

[Out] -1/315*(128*cos(x)^8-576*cos(x)^6+1008*cos(x)^4-840*cos(x)^2+315)*cos(x)*sin(x)*(a/sin(x)^4)^(5/2)

Maxima [A] time = 1.49922, size = 65, normalized size = 0.55

$$\frac{315 a^{\frac{5}{2}} \tan(x)^8 + 420 a^{\frac{5}{2}} \tan(x)^6 + 378 a^{\frac{5}{2}} \tan(x)^4 + 180 a^{\frac{5}{2}} \tan(x)^2 + 35 a^{\frac{5}{2}}}{315 \tan(x)^9}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^4)^(5/2),x, algorithm="maxima")

[Out]
$$-1/315*(315*a^{(5/2)}*\tan(x)^8 + 420*a^{(5/2)}*\tan(x)^6 + 378*a^{(5/2)}*\tan(x)^4 + 180*a^{(5/2)}*\tan(x)^2 + 35*a^{(5/2)})/\tan(x)^9$$

Fricas [A] time = 0.492788, size = 252, normalized size = 2.14

$$\frac{(128 a^2 \cos(x)^9 - 576 a^2 \cos(x)^7 + 1008 a^2 \cos(x)^5 - 840 a^2 \cos(x)^3 + 315 a^2 \cos(x)) \sqrt{\frac{a}{\cos(x)^4 - 2 \cos(x)^2 + 1}}}{315 (\cos(x)^6 - 3 \cos(x)^4 + 3 \cos(x)^2 - 1) \sin(x)}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^4)^(5/2),x, algorithm="fricas")

[Out]
$$1/315*(128*a^2*\cos(x)^9 - 576*a^2*\cos(x)^7 + 1008*a^2*\cos(x)^5 - 840*a^2*\cos(x)^3 + 315*a^2*\cos(x))*\sqrt{a/(\cos(x)^4 - 2*\cos(x)^2 + 1)}/((\cos(x)^6 - 3*\cos(x)^4 + 3*\cos(x)^2 - 1)*\sin(x))$$

Sympy [F(-1)] time = 0., size = 0, normalized size = 0.

Timed out

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)**4)**(5/2),x)

[Out] Timed out

Giac [A] time = 1.27646, size = 69, normalized size = 0.58

$$\frac{(315 a^2 \tan(x)^8 + 420 a^2 \tan(x)^6 + 378 a^2 \tan(x)^4 + 180 a^2 \tan(x)^2 + 35 a^2) \sqrt{a}}{315 \tan(x)^9}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^4)^(5/2),x, algorithm="giac")

```
[Out] -1/315*(315*a^2*tan(x)^8 + 420*a^2*tan(x)^6 + 378*a^2*tan(x)^4 + 180*a^2*tan(x)^2 + 35*a^2)*sqrt(a)/tan(x)^9
```

3.63 $\int \left(a \csc^4(x) \right)^{3/2} dx$

Optimal. Leaf size=62

$$-\frac{1}{5}a \cos^2(x) \cot^3(x) \sqrt{a \csc^4(x)} - \frac{2}{3}a \cos^2(x) \cot(x) \sqrt{a \csc^4(x)} - a \sin(x) \cos(x) \sqrt{a \csc^4(x)}$$

[Out] $(-2*a*\cos[x]^2*\cot[x]*\sqrt{a*\csc[x]^4})/3 - (a*\cos[x]^2*\cot[x]^3*\sqrt{a*\csc[x]^4})/5 - a*\cos[x]*\sqrt{a*\csc[x]^4}*\sin[x]$

Rubi [A] time = 0.0209453, antiderivative size = 62, normalized size of antiderivative = 1., number of steps used = 3, number of rules used = 2, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.2$, Rules used = {4123, 3767}

$$-\frac{1}{5}a \cos^2(x) \cot^3(x) \sqrt{a \csc^4(x)} - \frac{2}{3}a \cos^2(x) \cot(x) \sqrt{a \csc^4(x)} - a \sin(x) \cos(x) \sqrt{a \csc^4(x)}$$

Antiderivative was successfully verified.

[In] $\text{Int}[(a*\csc[x]^4)^{(3/2)}, x]$

[Out] $(-2*a*\cos[x]^2*\cot[x]*\sqrt{a*\csc[x]^4})/3 - (a*\cos[x]^2*\cot[x]^3*\sqrt{a*\csc[x]^4})/5 - a*\cos[x]*\sqrt{a*\csc[x]^4}*\sin[x]$

Rule 4123

$\text{Int}[(b_*)*((c_*)*\sec[(e_*) + (f_*)*(x_)])^{(n_)]^{(p_)}, x_Symbol] \rightarrow \text{Dist}[(b \wedge \text{IntPart}[p]*(c*(\csc[e + f*x])^n)^{\text{FracPart}[p]})/(c*\sec[e + f*x])^{(n*\text{FracPart}[p])}], \text{Int}[(c*\sec[e + f*x])^{(n*p)}, x], x] /; \text{FreeQ}\{b, c, e, f, n, p\}, x] \& \& \text{!IntegerQ}[p]$

Rule 3767

$\text{Int}[\csc[(c_*) + (d_*)*(x_)]^{(n_)}, x_Symbol] \rightarrow -\text{Dist}[d^{(-1)}, \text{Subst}[\text{Int}[\text{ExpandIntegrand}[(1 + x^2)^{(n/2 - 1)}, x], x], x, \cot[c + d*x]], x] /; \text{FreeQ}\{c, d\}, x] \&\& \text{IGtQ}[n/2, 0]$

Rubi steps

$$\begin{aligned}
\int (a \csc^4(x))^{3/2} dx &= \left(a \sqrt{a \csc^4(x) \sin^2(x)} \right) \int \csc^6(x) dx \\
&= - \left(\left(a \sqrt{a \csc^4(x) \sin^2(x)} \right) \text{Subst} \left(\int (1 + 2x^2 + x^4) dx, x, \cot(x) \right) \right) \\
&= -\frac{2}{3} a \cos^2(x) \cot(x) \sqrt{a \csc^4(x)} - \frac{1}{5} a \cos^2(x) \cot^3(x) \sqrt{a \csc^4(x)} - a \cos(x) \sqrt{a \csc^4(x)} \sin(x)
\end{aligned}$$

Mathematica [A] time = 0.0199325, size = 33, normalized size = 0.53

$$-\frac{1}{15} a \sin(x) \cos(x) (3 \csc^4(x) + 4 \csc^2(x) + 8) \sqrt{a \csc^4(x)}$$

Antiderivative was successfully verified.

[In] Integrate[(a*Csc[x]^4)^(3/2), x]

[Out] -(a*cos[x]*Sqrt[a*Csc[x]^4]*(8 + 4*Csc[x]^2 + 3*Csc[x]^4)*Sin[x])/15

Maple [A] time = 0.096, size = 29, normalized size = 0.5

$$-\frac{(8 (\cos(x))^4 - 20 (\cos(x))^2 + 15) \cos(x) \sin(x)}{15} \left(\frac{a}{(\sin(x))^4} \right)^{\frac{3}{2}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int((a*csc(x)^4)^(3/2), x)

[Out] -1/15*(8*cos(x)^4-20*cos(x)^2+15)*cos(x)*sin(x)*(a/sin(x)^4)^(3/2)

Maxima [A] time = 1.51077, size = 41, normalized size = 0.66

$$-\frac{15 a^{\frac{3}{2}} \tan(x)^4 + 10 a^{\frac{3}{2}} \tan(x)^2 + 3 a^{\frac{3}{2}}}{15 \tan(x)^5}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^4)^(3/2),x, algorithm="maxima")

[Out] $-1/15*(15*a^{(3/2)}*\tan(x)^4 + 10*a^{(3/2)}*\tan(x)^2 + 3*a^{(3/2)})/\tan(x)^5$

Fricas [A] time = 0.471147, size = 150, normalized size = 2.42

$$\frac{(8 a \cos(x)^5 - 20 a \cos(x)^3 + 15 a \cos(x)) \sqrt{\frac{a}{\cos(x)^4 - 2 \cos(x)^2 + 1}}}{15 (\cos(x)^2 - 1) \sin(x)}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^4)^(3/2),x, algorithm="fricas")

[Out] $1/15*(8*a*\cos(x)^5 - 20*a*\cos(x)^3 + 15*a*\cos(x))*\sqrt{a/(\cos(x)^4 - 2*\cos(x)^2 + 1)}/((\cos(x)^2 - 1)*\sin(x))$

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int (a \csc^4(x))^{\frac{3}{2}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)**4)**(3/2),x)

[Out] Integral((a*csc(x)**4)**(3/2), x)

Giac [A] time = 1.2962, size = 31, normalized size = 0.5

$$\frac{(15 \tan(x)^4 + 10 \tan(x)^2 + 3)a^{\frac{3}{2}}}{15 \tan(x)^5}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^4)^(3/2),x, algorithm="giac")

[Out] $-1/15*(15*\tan(x)^4 + 10*\tan(x)^2 + 3)*a^{(3/2)}/\tan(x)^5$

3.64 $\int \sqrt{a \csc^4(x)} dx$

Optimal. Leaf size=16

$$\sin(x)(-\cos(x))\sqrt{a \csc^4(x)}$$

[Out] $-(\text{Cos}[x] * \text{Sqrt}[a * \text{Csc}[x]^4] * \text{Sin}[x])$

Rubi [A] time = 0.0147763, antiderivative size = 16, normalized size of antiderivative = 1., number of steps used = 3, number of rules used = 3, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.3$, Rules used = {4123, 3767, 8}

$$\sin(x)(-\cos(x))\sqrt{a \csc^4(x)}$$

Antiderivative was successfully verified.

[In] $\text{Int}[\text{Sqrt}[a * \text{Csc}[x]^4], x]$

[Out] $-(\text{Cos}[x] * \text{Sqrt}[a * \text{Csc}[x]^4] * \text{Sin}[x])$

Rule 4123

$\text{Int}[(b * (c * \sec[e + f * x] + (d * x)^n))^p, x_Symbol] \rightarrow \text{Dist}[b^{\text{IntPart}[p]} * (c * \sec[e + f * x])^{\text{FracPart}[p]} / (c * \sec[e + f * x])^{n * \text{FracPart}[p]}, \text{Int}[(c * \sec[e + f * x])^{n * p}, x], x] /;$ FreeQ[{b, c, e, f, n, p}, x] & !IntegerQ[p]

Rule 3767

$\text{Int}[\csc[(c + d * x)^n], x_Symbol] \rightarrow -\text{Dist}[d^{-1}, \text{Subst}[\text{Int}[\text{ExpandIntegrand}[(1 + x^2)^{n/2 - 1}, x], x], x, \text{Cot}[c + d * x]], x] /;$ FreeQ[{c, d}, x] && IGtQ[n/2, 0]

Rule 8

$\text{Int}[a, x_Symbol] \rightarrow \text{Simp}[a * x, x] /;$ FreeQ[a, x]

Rubi steps

$$\begin{aligned}
 \int \sqrt{a \csc^4(x)} dx &= \left(\sqrt{a \csc^4(x) \sin^2(x)} \right) \int \csc^2(x) dx \\
 &= - \left(\left(\sqrt{a \csc^4(x) \sin^2(x)} \right) \text{Subst} \left(\int 1 dx, x, \cot(x) \right) \right) \\
 &= - \cos(x) \sqrt{a \csc^4(x)} \sin(x)
 \end{aligned}$$

Mathematica [A] time = 0.0060438, size = 16, normalized size = 1.

$$\sin(x)(-\cos(x))\sqrt{a \csc^4(x)}$$

Antiderivative was successfully verified.

[In] Integrate[Sqrt[a*Csc[x]^4],x]

[Out] -(Cos[x]*Sqrt[a*Csc[x]^4]*Sin[x])

Maple [A] time = 0.138, size = 18, normalized size = 1.1

$$-\frac{\sqrt{16} \sin(x) \cos(x)}{4} \sqrt{\frac{a}{(\sin(x))^4}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int((a*csc(x)^4)^(1/2),x)

[Out] -1/4*16^(1/2)*sin(x)*cos(x)*(a/sin(x)^4)^(1/2)

Maxima [A] time = 1.52784, size = 12, normalized size = 0.75

$$-\frac{\sqrt{a}}{\tan(x)}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(x)^4)^(1/2),x, algorithm="maxima")

[Out] $-\sqrt{a}/\tan(x)$

Fricas [A] time = 0.46573, size = 70, normalized size = 4.38

$$-\sqrt{\frac{a}{\cos(x)^4 - 2\cos(x)^2 + 1}} \cos(x) \sin(x)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate((a*csc(x)^4)^(1/2),x, algorithm="fricas")`

[Out] $-\sqrt{a/(\cos(x)^4 - 2\cos(x)^2 + 1)}*\cos(x)*\sin(x)$

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \sqrt{a \csc^4(x)} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate((a*csc(x)**4)**(1/2),x)`

[Out] `Integral(sqrt(a*csc(x)**4), x)`

Giac [A] time = 1.35062, size = 12, normalized size = 0.75

$$-\frac{\sqrt{a}}{\tan(x)}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate((a*csc(x)^4)^(1/2),x, algorithm="giac")`

[Out] $-\sqrt{a}/\tan(x)$

$$3.65 \quad \int \frac{1}{\sqrt{a} \csc^4(x)} dx$$

Optimal. Leaf size=36

$$\frac{x \csc^2(x)}{2\sqrt{a} \csc^4(x)} - \frac{\cot(x)}{2\sqrt{a} \csc^4(x)}$$

[Out] $-\text{Cot}[x]/(2*\text{Sqrt}[a*\text{Csc}[x]^4]) + (x*\text{Csc}[x]^2)/(2*\text{Sqrt}[a*\text{Csc}[x]^4])$

Rubi [A] time = 0.01555, antiderivative size = 36, normalized size of antiderivative = 1., number of steps used = 3, number of rules used = 3, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.3$, Rules used = {4123, 2635, 8}

$$\frac{x \csc^2(x)}{2\sqrt{a} \csc^4(x)} - \frac{\cot(x)}{2\sqrt{a} \csc^4(x)}$$

Antiderivative was successfully verified.

[In] $\text{Int}[1/\text{Sqrt}[a*\text{Csc}[x]^4], x]$

[Out] $-\text{Cot}[x]/(2*\text{Sqrt}[a*\text{Csc}[x]^4]) + (x*\text{Csc}[x]^2)/(2*\text{Sqrt}[a*\text{Csc}[x]^4])$

Rule 4123

```
Int[((b_.)*((c_.)*sec[(e_.) + (f_.)*(x_)])^(n_.))^(p_), x_Symbol] :> Dist[(b
^IntPart[p]*(b*(c*Sec[e + f*x])^n)^FracPart[p])/(c*Sec[e + f*x])^(n*FracPar
t[p]), Int[(c*Sec[e + f*x])^(n*p), x], x] /; FreeQ[{b, c, e, f, n, p}, x] &
& !IntegerQ[p]
```

Rule 2635

```
Int[((b_.)*sin[(c_.) + (d_.)*(x_)])^(n_), x_Symbol] :> -Simp[(b*cos[c + d*x
]*(b*sin[c + d*x])^(n - 1))/(d*n), x] + Dist[(b^2*(n - 1))/n, Int[(b*sin[c
+ d*x])^(n - 2), x], x] /; FreeQ[{b, c, d}, x] && GtQ[n, 1] && IntegerQ[2*n
]
```

Rule 8

```
Int[a_, x_Symbol] :> Simp[a*x, x] /; FreeQ[a, x]
```

Rubi steps

$$\begin{aligned}
\int \frac{1}{\sqrt{a \csc^4(x)}} dx &= \frac{\csc^2(x) \int \sin^2(x) dx}{\sqrt{a \csc^4(x)}} \\
&= -\frac{\cot(x)}{2\sqrt{a \csc^4(x)}} + \frac{\csc^2(x) \int 1 dx}{2\sqrt{a \csc^4(x)}} \\
&= -\frac{\cot(x)}{2\sqrt{a \csc^4(x)}} + \frac{x \csc^2(x)}{2\sqrt{a \csc^4(x)}}
\end{aligned}$$

Mathematica [A] time = 0.0252097, size = 25, normalized size = 0.69

$$\frac{x \csc^2(x) - \cot(x)}{2\sqrt{a \csc^4(x)}}$$

Antiderivative was successfully verified.

[In] Integrate[1/Sqrt[a*Csc[x]^4], x]

[Out] (-Cot[x] + x*Csc[x]^2)/(2*Sqrt[a*Csc[x]^4])

Maple [A] time = 0.163, size = 24, normalized size = 0.7

$$-\frac{\cos(x) \sin(x) - x}{2 (\sin(x))^2} \frac{1}{\sqrt{\frac{a}{(\sin(x))^4}}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(1/(a*csc(x)^4)^(1/2), x)

[Out] -1/2*(cos(x)*sin(x)-x)/sin(x)^2/(a/sin(x)^4)^(1/2)

Maxima [A] time = 1.49717, size = 34, normalized size = 0.94

$$\frac{x}{2\sqrt{a}} - \frac{\tan(x)}{2(\sqrt{a}\tan(x)^2 + \sqrt{a})}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(a*csc(x)^4)^(1/2),x, algorithm="maxima")`

[Out] `1/2*x/sqrt(a) - 1/2*tan(x)/(sqrt(a)*tan(x)^2 + sqrt(a))`

Fricas [A] time = 0.488808, size = 122, normalized size = 3.39

$$\frac{\left(x \cos(x)^2 - (\cos(x)^3 - \cos(x)) \sin(x) - x\right) \sqrt{\frac{a}{\cos(x)^4 - 2 \cos(x)^2 + 1}}}{2a}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(a*csc(x)^4)^(1/2),x, algorithm="fricas")`

[Out] `-1/2*(x*cos(x)^2 - (cos(x)^3 - cos(x))*sin(x) - x)*sqrt(a/(cos(x)^4 - 2*cos(x)^2 + 1))/a`

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{\sqrt{a \csc^4(x)}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(a*csc(x)**4)**(1/2),x)`

[Out] `Integral(1/sqrt(a*csc(x)**4), x)`

Giac [F(-2)] time = 0., size = 0, normalized size = 0.

Exception raised: TypeError

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(a*csc(x)^4)^(1/2),x, algorithm="giac")`

[Out] Exception raised: TypeError

$$3.66 \quad \int \frac{1}{(a \csc^4(x))^{3/2}} dx$$

Optimal. Leaf size=86

$$\frac{5x \csc^2(x)}{16a\sqrt{a \csc^4(x)}} - \frac{5 \cot(x)}{16a\sqrt{a \csc^4(x)}} - \frac{\sin^3(x) \cos(x)}{6a\sqrt{a \csc^4(x)}} - \frac{5 \sin(x) \cos(x)}{24a\sqrt{a \csc^4(x)}}$$

[Out] $(-5*\text{Cot}[x])/(16*a*\text{Sqrt}[a*\text{Csc}[x]^4]) + (5*x*\text{Csc}[x]^2)/(16*a*\text{Sqrt}[a*\text{Csc}[x]^4]) - (5*\text{Cos}[x]*\text{Sin}[x])/(24*a*\text{Sqrt}[a*\text{Csc}[x]^4]) - (\text{Cos}[x]*\text{Sin}[x]^3)/(6*a*\text{Sqrt}[a*\text{Csc}[x]^4])$

Rubi [A] time = 0.0294559, antiderivative size = 86, normalized size of antiderivative = 1., number of steps used = 5, number of rules used = 3, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.3$, Rules used = {4123, 2635, 8}

$$\frac{5x \csc^2(x)}{16a\sqrt{a \csc^4(x)}} - \frac{5 \cot(x)}{16a\sqrt{a \csc^4(x)}} - \frac{\sin^3(x) \cos(x)}{6a\sqrt{a \csc^4(x)}} - \frac{5 \sin(x) \cos(x)}{24a\sqrt{a \csc^4(x)}}$$

Antiderivative was successfully verified.

[In] $\text{Int}[(a*\text{Csc}[x]^4)^{-3/2}, x]$

[Out] $(-5*\text{Cot}[x])/(16*a*\text{Sqrt}[a*\text{Csc}[x]^4]) + (5*x*\text{Csc}[x]^2)/(16*a*\text{Sqrt}[a*\text{Csc}[x]^4]) - (5*\text{Cos}[x]*\text{Sin}[x])/(24*a*\text{Sqrt}[a*\text{Csc}[x]^4]) - (\text{Cos}[x]*\text{Sin}[x]^3)/(6*a*\text{Sqrt}[a*\text{Csc}[x]^4])$

Rule 4123

$\text{Int}[(b_.)*((c_.)*\text{sec}[e_.] + (f_.)*(x_.))]^{(n_.)}^{(p_.)}, x_Symbol] \rightarrow \text{Dist}[(b \wedge \text{IntPart}[p])*(b*(c*\text{Sec}[e + f*x])^n)^{\text{FracPart}[p]}]/(c*\text{Sec}[e + f*x])^{(n*\text{FracPart}[p])}, \text{Int}[(c*\text{Sec}[e + f*x])^{(n*p)}, x], x] /; \text{FreeQ}\{b, c, e, f, n, p\}, x] \& \& !\text{IntegerQ}[p]$

Rule 2635

$\text{Int}[(b_.)*\sin[(c_.) + (d_.)*(x_.))]^{(n_.)}, x_Symbol] \rightarrow -\text{Simp}[(b*\text{Cos}[c + d*x])*(b*\text{Sin}[c + d*x])^{(n-1)}]/(d*n), x] + \text{Dist}[(b^2*(n-1))/n, \text{Int}[(b*\text{Sin}[c + d*x])^{(n-2)}, x], x] /; \text{FreeQ}\{b, c, d\}, x] \&\& \text{GtQ}[n, 1] \&\& \text{IntegerQ}[2*n]$

Rule 8

`Int[a_, x_Symbol] := Simp[a*x, x] /; FreeQ[a, x]`

Rubi steps

$$\begin{aligned}
 \int \frac{1}{(a \csc^4(x))^{3/2}} dx &= \frac{\csc^2(x) \int \sin^6(x) dx}{a\sqrt{a} \csc^4(x)} \\
 &= -\frac{\cos(x) \sin^3(x)}{6a\sqrt{a} \csc^4(x)} + \frac{(5 \csc^2(x)) \int \sin^4(x) dx}{6a\sqrt{a} \csc^4(x)} \\
 &= -\frac{5 \cos(x) \sin(x)}{24a\sqrt{a} \csc^4(x)} - \frac{\cos(x) \sin^3(x)}{6a\sqrt{a} \csc^4(x)} + \frac{(5 \csc^2(x)) \int \sin^2(x) dx}{8a\sqrt{a} \csc^4(x)} \\
 &= -\frac{5 \cot(x)}{16a\sqrt{a} \csc^4(x)} - \frac{5 \cos(x) \sin(x)}{24a\sqrt{a} \csc^4(x)} - \frac{\cos(x) \sin^3(x)}{6a\sqrt{a} \csc^4(x)} + \frac{(5 \csc^2(x)) \int 1 dx}{16a\sqrt{a} \csc^4(x)} \\
 &= -\frac{5 \cot(x)}{16a\sqrt{a} \csc^4(x)} + \frac{5x \csc^2(x)}{16a\sqrt{a} \csc^4(x)} - \frac{5 \cos(x) \sin(x)}{24a\sqrt{a} \csc^4(x)} - \frac{\cos(x) \sin^3(x)}{6a\sqrt{a} \csc^4(x)}
 \end{aligned}$$

Mathematica [A] time = 0.0429218, size = 38, normalized size = 0.44

$$\frac{(-60x + 45 \sin(2x) - 9 \sin(4x) + \sin(6x)) \csc^6(x)}{192 (a \csc^4(x))^{3/2}}$$

Antiderivative was successfully verified.

[In] Integrate[(a*Csc[x]^4)^(-3/2), x]

[Out] -(Csc[x]^6*(-60*x + 45*Sin[2*x] - 9*Sin[4*x] + Sin[6*x]))/(192*(a*Csc[x]^4)^(3/2))

Maple [A] time = 0.205, size = 41, normalized size = 0.5

$$\frac{8 \sin(x) (\cos(x))^5 - 26 \sin(x) (\cos(x))^3 + 33 \cos(x) \sin(x) - 15x}{48 (\sin(x))^6} \left(\frac{a}{(\sin(x))^4} \right)^{-3/2}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `int(1/(a*csc(x)^4)^(3/2),x)`

[Out]
$$-1/48*(8*\sin(x)*\cos(x)^5-26*\sin(x)*\cos(x)^3+33*\cos(x)*\sin(x)-15*x)/(a/\sin(x)^4)^(3/2)/\sin(x)^6$$

Maxima [A] time = 1.5244, size = 78, normalized size = 0.91

$$-\frac{33 \tan(x)^5 + 40 \tan(x)^3 + 15 \tan(x)}{48 \left(a^{\frac{3}{2}} \tan(x)^6 + 3 a^{\frac{3}{2}} \tan(x)^4 + 3 a^{\frac{3}{2}} \tan(x)^2 + a^{\frac{3}{2}} \right)} + \frac{5x}{16 a^{\frac{3}{2}}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(a*csc(x)^4)^(3/2),x, algorithm="maxima")`

[Out]
$$-1/48*(33*\tan(x)^5 + 40*\tan(x)^3 + 15*\tan(x))/(a^(3/2)*\tan(x)^6 + 3*a^(3/2)*\tan(x)^4 + 3*a^(3/2)*\tan(x)^2 + a^(3/2)) + 5/16*x/a^(3/2)$$

Fricas [A] time = 0.495052, size = 178, normalized size = 2.07

$$\frac{(15x \cos(x)^2 - (8 \cos(x)^7 - 34 \cos(x)^5 + 59 \cos(x)^3 - 33 \cos(x)) \sin(x) - 15x) \sqrt{\frac{a}{\cos(x)^4 - 2 \cos(x)^2 + 1}}}{48 a^2}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(a*csc(x)^4)^(3/2),x, algorithm="fricas")`

[Out]
$$-1/48*(15*x*\cos(x)^2 - (8*\cos(x)^7 - 34*\cos(x)^5 + 59*\cos(x)^3 - 33*\cos(x))*\sin(x) - 15*x)*\sqrt{a/(\cos(x)^4 - 2*\cos(x)^2 + 1)}/a^2$$

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(a \csc^4(x))^{\frac{3}{2}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/(a*csc(x)**4)**(3/2),x)
```

```
[Out] Integral((a*csc(x)**4)**(-3/2), x)
```

Giac [F(-2)] time = 0., size = 0, normalized size = 0.

Exception raised: TypeError

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(1/(a*csc(x)^4)^(3/2),x, algorithm="giac")
```

```
[Out] Exception raised: TypeError
```


$$3.67 \quad \int \frac{1}{(a \csc^4(x))^{5/2}} dx$$

Optimal. Leaf size=132

$$\frac{63x \csc^2(x)}{256a^2\sqrt{a \csc^4(x)}} - \frac{63 \cot(x)}{256a^2\sqrt{a \csc^4(x)}} - \frac{\sin^7(x) \cos(x)}{10a^2\sqrt{a \csc^4(x)}} - \frac{9 \sin^5(x) \cos(x)}{80a^2\sqrt{a \csc^4(x)}} - \frac{21 \sin^3(x) \cos(x)}{160a^2\sqrt{a \csc^4(x)}} - \frac{21 \sin(x) \cos(x)}{128a^2\sqrt{a \csc^4(x)}}$$

[Out] $(-63*\text{Cot}[x])/(256*a^2*\text{Sqrt}[a*\text{Csc}[x]^4]) + (63*x*\text{Csc}[x]^2)/(256*a^2*\text{Sqrt}[a*\text{Csc}[x]^4]) - (21*\text{Cos}[x]*\text{Sin}[x])/(128*a^2*\text{Sqrt}[a*\text{Csc}[x]^4]) - (21*\text{Cos}[x]*\text{Sin}[x]^3)/(160*a^2*\text{Sqrt}[a*\text{Csc}[x]^4]) - (9*\text{Cos}[x]*\text{Sin}[x]^5)/(80*a^2*\text{Sqrt}[a*\text{Csc}[x]^4]) - (\text{Cos}[x]*\text{Sin}[x]^7)/(10*a^2*\text{Sqrt}[a*\text{Csc}[x]^4])$

Rubi [A] time = 0.0446798, antiderivative size = 132, normalized size of antiderivative = 1., number of steps used = 7, number of rules used = 3, integrand size = 10, $\frac{\text{number of rules}}{\text{integrand size}} = 0.3$, Rules used = {4123, 2635, 8}

$$\frac{63x \csc^2(x)}{256a^2\sqrt{a \csc^4(x)}} - \frac{63 \cot(x)}{256a^2\sqrt{a \csc^4(x)}} - \frac{\sin^7(x) \cos(x)}{10a^2\sqrt{a \csc^4(x)}} - \frac{9 \sin^5(x) \cos(x)}{80a^2\sqrt{a \csc^4(x)}} - \frac{21 \sin^3(x) \cos(x)}{160a^2\sqrt{a \csc^4(x)}} - \frac{21 \sin(x) \cos(x)}{128a^2\sqrt{a \csc^4(x)}}$$

Antiderivative was successfully verified.

[In] $\text{Int}[(a*\text{Csc}[x]^4)^{-5/2}, x]$

[Out] $(-63*\text{Cot}[x])/(256*a^2*\text{Sqrt}[a*\text{Csc}[x]^4]) + (63*x*\text{Csc}[x]^2)/(256*a^2*\text{Sqrt}[a*\text{Csc}[x]^4]) - (21*\text{Cos}[x]*\text{Sin}[x])/(128*a^2*\text{Sqrt}[a*\text{Csc}[x]^4]) - (21*\text{Cos}[x]*\text{Sin}[x]^3)/(160*a^2*\text{Sqrt}[a*\text{Csc}[x]^4]) - (9*\text{Cos}[x]*\text{Sin}[x]^5)/(80*a^2*\text{Sqrt}[a*\text{Csc}[x]^4]) - (\text{Cos}[x]*\text{Sin}[x]^7)/(10*a^2*\text{Sqrt}[a*\text{Csc}[x]^4])$

Rule 4123

$\text{Int}[(b_*)*((c_*)*\text{sec}[e_*] + (f_*)(x_*))]^{(n_*)}{}^{(p_*)}, x_Symbol] \rightarrow \text{Dist}[(b_*\text{IntPart}[p]*\text{IntPart}[p])*(b*(c*\text{Sec}[e + f*x])^n)^{\text{FracPart}[p]}/(c*\text{Sec}[e + f*x])^{(n*\text{FracPart}[p])}, \text{Int}[(c*\text{Sec}[e + f*x])^{(n*p)}, x], x] /;$ FreeQ[{b, c, e, f, n, p}, x] && !IntegerQ[p]

Rule 2635

$\text{Int}[(b_*)*\text{sin}[(c_*) + (d_*)(x_*)]^{(n_*)}, x_Symbol] \rightarrow -\text{Simp}[(b*\text{Cos}[c + d*x])*(b*\text{Sin}[c + d*x])^{(n-1)}]/(d*n), x] + \text{Dist}[(b^2*(n-1))/n, \text{Int}[(b*\text{Sin}[c + d*x])^{(n-2)}, x], x] /;$ FreeQ[{b, c, d}, x] && GtQ[n, 1] && IntegerQ[2*n]

]

Rule 8

Int[a_, x_Symbol] := Simp[a*x, x] /; FreeQ[a, x]

Rubi steps

$$\begin{aligned}
\int \frac{1}{(a \csc^4(x))^{5/2}} dx &= \frac{\csc^2(x) \int \sin^{10}(x) dx}{a^2 \sqrt{a \csc^4(x)}} \\
&= -\frac{\cos(x) \sin^7(x)}{10a^2 \sqrt{a \csc^4(x)}} + \frac{(9 \csc^2(x)) \int \sin^8(x) dx}{10a^2 \sqrt{a \csc^4(x)}} \\
&= -\frac{9 \cos(x) \sin^5(x)}{80a^2 \sqrt{a \csc^4(x)}} - \frac{\cos(x) \sin^7(x)}{10a^2 \sqrt{a \csc^4(x)}} + \frac{(63 \csc^2(x)) \int \sin^6(x) dx}{80a^2 \sqrt{a \csc^4(x)}} \\
&= -\frac{21 \cos(x) \sin^3(x)}{160a^2 \sqrt{a \csc^4(x)}} - \frac{9 \cos(x) \sin^5(x)}{80a^2 \sqrt{a \csc^4(x)}} - \frac{\cos(x) \sin^7(x)}{10a^2 \sqrt{a \csc^4(x)}} + \frac{(21 \csc^2(x)) \int \sin^4(x) dx}{32a^2 \sqrt{a \csc^4(x)}} \\
&= -\frac{21 \cos(x) \sin(x)}{128a^2 \sqrt{a \csc^4(x)}} - \frac{21 \cos(x) \sin^3(x)}{160a^2 \sqrt{a \csc^4(x)}} - \frac{9 \cos(x) \sin^5(x)}{80a^2 \sqrt{a \csc^4(x)}} - \frac{\cos(x) \sin^7(x)}{10a^2 \sqrt{a \csc^4(x)}} + \frac{(63 \csc^2(x)) \int \sin^2(x) dx}{128a^2 \sqrt{a \csc^4(x)}} \\
&= -\frac{63 \cot(x)}{256a^2 \sqrt{a \csc^4(x)}} - \frac{21 \cos(x) \sin(x)}{128a^2 \sqrt{a \csc^4(x)}} - \frac{21 \cos(x) \sin^3(x)}{160a^2 \sqrt{a \csc^4(x)}} - \frac{9 \cos(x) \sin^5(x)}{80a^2 \sqrt{a \csc^4(x)}} - \frac{\cos(x) \sin^7(x)}{10a^2 \sqrt{a \csc^4(x)}} + \\
&= -\frac{63 \cot(x)}{256a^2 \sqrt{a \csc^4(x)}} + \frac{63x \csc^2(x)}{256a^2 \sqrt{a \csc^4(x)}} - \frac{21 \cos(x) \sin(x)}{128a^2 \sqrt{a \csc^4(x)}} - \frac{21 \cos(x) \sin^3(x)}{160a^2 \sqrt{a \csc^4(x)}} - \frac{9 \cos(x) \sin^5(x)}{80a^2 \sqrt{a \csc^4(x)}}
\end{aligned}$$

Mathematica [A] time = 0.0948023, size = 55, normalized size = 0.42

$$\frac{\sin^2(x)(2520x - 2100 \sin(2x) + 600 \sin(4x) - 150 \sin(6x) + 25 \sin(8x) - 2 \sin(10x))\sqrt{a \csc^4(x)}}{10240a^3}$$

Antiderivative was successfully verified.

[In] Integrate[(a*Csc[x]^4)^(-5/2), x]

[Out] (Sqrt[a*Csc[x]^4]*Sin[x]^2*(2520*x - 2100*Sin[2*x] + 600*Sin[4*x] - 150*Sin[6*x] + 25*Sin[8*x] - 2*Sin[10*x]))/(10240*a^3)

Maple [A] time = 0.245, size = 57, normalized size = 0.4

$$\frac{128 \sin(x) (\cos(x))^9 - 656 \sin(x) (\cos(x))^7 + 1368 \sin(x) (\cos(x))^5 - 1490 \sin(x) (\cos(x))^3 + 965 \cos(x) \sin(x) - 315x}{1280 (\sin(x))^{10}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `int(1/(a*csc(x)^4)^(5/2),x)`

[Out] $-1/1280*(128*\sin(x)*\cos(x)^9-656*\sin(x)*\cos(x)^7+1368*\sin(x)*\cos(x)^5-1490*\sin(x)*\cos(x)^3+965*\cos(x)*\sin(x)-315*x)/(a/\sin(x)^4)^(5/2)/\sin(x)^{10}$

Maxima [A] time = 1.53539, size = 119, normalized size = 0.9

$$\frac{965 \tan(x)^9 + 2370 \tan(x)^7 + 2688 \tan(x)^5 + 1470 \tan(x)^3 + 315 \tan(x)}{1280 \left(a^{\frac{5}{2}} \tan(x)^{10} + 5 a^{\frac{5}{2}} \tan(x)^8 + 10 a^{\frac{5}{2}} \tan(x)^6 + 10 a^{\frac{5}{2}} \tan(x)^4 + 5 a^{\frac{5}{2}} \tan(x)^2 + a^{\frac{5}{2}} \right)} + \frac{63x}{256 a^{\frac{5}{2}}}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(a*csc(x)^4)^(5/2),x, algorithm="maxima")`

[Out] $-1/1280*(965*\tan(x)^9 + 2370*\tan(x)^7 + 2688*\tan(x)^5 + 1470*\tan(x)^3 + 315*\tan(x))/(a^(5/2)*\tan(x)^{10} + 5*a^(5/2)*\tan(x)^8 + 10*a^(5/2)*\tan(x)^6 + 10*a^(5/2)*\tan(x)^4 + 5*a^(5/2)*\tan(x)^2 + a^(5/2)) + 63/256*x/a^(5/2)$

Fricas [A] time = 0.523596, size = 236, normalized size = 1.79

$$\frac{(315x \cos(x)^2 - (128 \cos(x)^{11} - 784 \cos(x)^9 + 2024 \cos(x)^7 - 2858 \cos(x)^5 + 2455 \cos(x)^3 - 965 \cos(x)) \sin(x) - 315x) \sqrt{a/(\cos(x)^4 - 2 \cos(x)^2 + 1)}}{1280 a^3}$$

Verification of antiderivative is not currently implemented for this CAS.

[In] `integrate(1/(a*csc(x)^4)^(5/2),x, algorithm="fricas")`

[Out] $-1/1280*(315*x*\cos(x)^2 - (128*\cos(x)^{11} - 784*\cos(x)^9 + 2024*\cos(x)^7 - 2858*\cos(x)^5 + 2455*\cos(x)^3 - 965*\cos(x))*\sin(x) - 315*x)*\sqrt{a/(\cos(x)^4 - 2*\cos(x)^2 + 1)}/a^3$

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \frac{1}{(a \csc^4(x))^{\frac{5}{2}}} dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(a*csc(x)**4)**(5/2),x)

[Out] Integral((a*csc(x)**4)**(-5/2), x)

Giac [F(-2)] time = 0., size = 0, normalized size = 0.

Exception raised: TypeError

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(1/(a*csc(x)^4)^(5/2),x, algorithm="giac")

[Out] Exception raised: TypeError

3.68 $\int ((b \csc(c + dx))^p)^n dx$

Optimal. Leaf size=80

$$\frac{\sin(c + dx) \cos(c + dx) ((b \csc(c + dx))^p)^n \operatorname{Hypergeometric2F1}\left(\frac{1}{2}, \frac{1}{2}(1 - np), \frac{1}{2}(3 - np), \sin^2(c + dx)\right)}{d(1 - np)\sqrt{\cos^2(c + dx)}}$$

[Out] (Cos[c + d*x]*((b*Csc[c + d*x])^p)^n*Hypergeometric2F1[1/2, (1 - n*p)/2, (3 - n*p)/2, Sin[c + d*x]^2]*Sin[c + d*x])/(d*(1 - n*p)*Sqrt[Cos[c + d*x]^2])

Rubi [A] time = 0.0495435, antiderivative size = 80, normalized size of antiderivative = 1., number of steps used = 3, number of rules used = 3, integrand size = 12, $\frac{\text{number of rules}}{\text{integrand size}} = 0.25$, Rules used = {4123, 3772, 2643}

$$\frac{\sin(c + dx) \cos(c + dx) ((b \csc(c + dx))^p)^n {}_2F_1\left(\frac{1}{2}, \frac{1}{2}(1 - np); \frac{1}{2}(3 - np); \sin^2(c + dx)\right)}{d(1 - np)\sqrt{\cos^2(c + dx)}}$$

Antiderivative was successfully verified.

[In] Int[((b*Csc[c + d*x])^p)^n,x]

[Out] (Cos[c + d*x]*((b*Csc[c + d*x])^p)^n*Hypergeometric2F1[1/2, (1 - n*p)/2, (3 - n*p)/2, Sin[c + d*x]^2]*Sin[c + d*x])/(d*(1 - n*p)*Sqrt[Cos[c + d*x]^2])

Rule 4123

Int[((b_.)*((c_.)*sec[(e_.) + (f_.)*(x_)])^(n_))^(p_), x_Symbol] := Dist[(b ^IntPart[p]*(b*(c*Sec[e + f*x])^n)^FracPart[p])/(c*Sec[e + f*x])^(n*FracPart[p]), Int[(c*Sec[e + f*x])^(n*p), x], x] /; FreeQ[{b, c, e, f, n, p}, x] && !IntegerQ[p]

Rule 3772

Int[(csc[(c_.) + (d_.)*(x_)])*(b_.))^(n_), x_Symbol] := Simp[(b*Csc[c + d*x])^(n - 1)*((Sin[c + d*x]/b)^(n - 1)*Int[1/(Sin[c + d*x]/b)^n, x]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[n]

Rule 2643

Int[((b_.)*sin[(c_.) + (d_.)*(x_)])^(n_), x_Symbol] := Simp[(Cos[c + d*x]*(b*Sin[c + d*x])^(n + 1)*Hypergeometric2F1[1/2, (n + 1)/2, (n + 3)/2, Sin[c

+ d*x]^2))/(b*d*(n + 1)*Sqrt[Cos[c + d*x]^2]), x] /; FreeQ[{b, c, d, n}, x]
&& !IntegerQ[2*n]

Rubi steps

$$\begin{aligned} \int ((b \csc(c + dx))^p)^n dx &= ((b \csc(c + dx))^{-np} ((b \csc(c + dx))^p)^n) \int (b \csc(c + dx))^{np} dx \\ &= \left(((b \csc(c + dx))^p)^n \left(\frac{\sin(c + dx)}{b} \right)^{np} \right) \int \left(\frac{\sin(c + dx)}{b} \right)^{-np} dx \\ &= \frac{\cos(c + dx) ((b \csc(c + dx))^p)^n {}_2F_1\left(\frac{1}{2}, \frac{1}{2}(1 - np); \frac{1}{2}(3 - np); \sin^2(c + dx)\right) \sin(c + dx)}{d(1 - np)\sqrt{\cos^2(c + dx)}} \end{aligned}$$

Mathematica [A] time = 0.114814, size = 71, normalized size = 0.89

$$\frac{\sin(c + dx) \cos(c + dx) \sin^2(c + dx)^{\frac{1}{2}(np-1)} ((b \csc(c + dx))^p)^n \text{Hypergeometric2F1}\left(\frac{1}{2}, \frac{1}{2}(np + 1), \frac{3}{2}, \cos^2(c + dx)\right)}{d}$$

Antiderivative was successfully verified.

[In] Integrate[((b*Csc[c + d*x])^p)^n,x]

[Out] -((Cos[c + d*x]*((b*Csc[c + d*x])^p)^n*Hypergeometric2F1[1/2, (1 + n*p)/2, 3/2, Cos[c + d*x]^2]*Sin[c + d*x]*(Sin[c + d*x]^2)^((-1 + n*p)/2))/d)

Maple [F] time = 0.765, size = 0, normalized size = 0.

$$\int ((b \csc(dx + c))^p)^n dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] int(((b*csc(d*x+c))^p)^n,x)

[Out] int(((b*csc(d*x+c))^p)^n,x)

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \left((b \csc(dx + c))^p \right)^n dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(((b*csc(d*x+c))^p)^n,x, algorithm="maxima")

[Out] integrate(((b*csc(d*x + c))^p)^n, x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\left((b \csc(dx + c))^p\right)^n, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(((b*csc(d*x+c))^p)^n,x, algorithm="fricas")

[Out] integral(((b*csc(d*x + c))^p)^n, x)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \left((b \csc(c + dx))^p \right)^n dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate(((b*csc(d*x+c))**p)**n,x)

[Out] Integral(((b*csc(c + d*x))**p)**n, x)

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \left((b \csc(dx + c))^p \right)^n dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate(((b*csc(d*x+c))^p)^n,x, algorithm="giac")
```

```
[Out] integrate(((b*csc(d*x + c))^p)^n, x)
```


3.69 $\int (a(b \csc(c + dx))^p)^n dx$

Optimal. Leaf size=82

$$\frac{\sin(c + dx) \cos(c + dx) \operatorname{Hypergeometric2F1}\left(\frac{1}{2}, \frac{1}{2}(1 - np), \frac{1}{2}(3 - np), \sin^2(c + dx)\right) (a(b \csc(c + dx))^p)^n}{d(1 - np) \sqrt{\cos^2(c + dx)}}$$

[Out] (Cos[c + d*x]*(a*(b*Csc[c + d*x])^p)^n*Hypergeometric2F1[1/2, (1 - n*p)/2, (3 - n*p)/2, Sin[c + d*x]^2]*Sin[c + d*x])/(d*(1 - n*p)*Sqrt[Cos[c + d*x]^2])

Rubi [A] time = 0.0491908, antiderivative size = 82, normalized size of antiderivative = 1., number of steps used = 3, number of rules used = 3, integrand size = 14, $\frac{\text{number of rules}}{\text{integrand size}} = 0.214$, Rules used = {4123, 3772, 2643}

$$\frac{\sin(c + dx) \cos(c + dx) {}_2F_1\left(\frac{1}{2}, \frac{1}{2}(1 - np); \frac{1}{2}(3 - np); \sin^2(c + dx)\right) (a(b \csc(c + dx))^p)^n}{d(1 - np) \sqrt{\cos^2(c + dx)}}$$

Antiderivative was successfully verified.

[In] Int[(a*(b*Csc[c + d*x])^p)^n,x]

[Out] (Cos[c + d*x]*(a*(b*Csc[c + d*x])^p)^n*Hypergeometric2F1[1/2, (1 - n*p)/2, (3 - n*p)/2, Sin[c + d*x]^2]*Sin[c + d*x])/(d*(1 - n*p)*Sqrt[Cos[c + d*x]^2])

Rule 4123

Int[((b_.)*((c_.)*sec[(e_.) + (f_.)*(x_)])^(n_))^(p_), x_Symbol] := Dist[(b^IntPart[p]*(b*(c*Sec[e + f*x])^n)^FracPart[p])/(c*Sec[e + f*x])^(n*FracPart[p]), Int[(c*Sec[e + f*x])^(n*p), x], x] /; FreeQ[{b, c, e, f, n, p}, x] && !IntegerQ[p]

Rule 3772

Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Simp[(b*Csc[c + d*x])^(n - 1)*((Sin[c + d*x]/b)^(n - 1)*Int[1/(Sin[c + d*x]/b)^n, x]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[n]

Rule 2643

```
Int[((b_.)*sin[(c_.) + (d_.)*(x_)])^(n_), x_Symbol] := Simp[(Cos[c + d*x]*(
b*Sin[c + d*x])^(n + 1)*Hypergeometric2F1[1/2, (n + 1)/2, (n + 3)/2, Sin[c
+ d*x]^2)]/(b*d*(n + 1)*Sqrt[Cos[c + d*x]^2]), x] /; FreeQ[{b, c, d, n}, x]
&& !IntegerQ[2*n]
```

Rubi steps

$$\begin{aligned} \int (a(b \csc(c + dx))^p)^n dx &= ((b \csc(c + dx))^{-np} (a(b \csc(c + dx))^p)^n) \int (b \csc(c + dx))^{np} dx \\ &= \left((a(b \csc(c + dx))^p)^n \left(\frac{\sin(c + dx)}{b} \right)^{np} \right) \int \left(\frac{\sin(c + dx)}{b} \right)^{-np} dx \\ &= \frac{\cos(c + dx) (a(b \csc(c + dx))^p)^n {}_2F_1\left(\frac{1}{2}, \frac{1}{2}(1 - np); \frac{1}{2}(3 - np); \sin^2(c + dx)\right) \sin(c + dx)}{d(1 - np)\sqrt{\cos^2(c + dx)}} \end{aligned}$$

Mathematica [A] time = 0.088213, size = 73, normalized size = 0.89

$$\frac{\sin(c + dx) \cos(c + dx) \sin^2(c + dx)^{\frac{1}{2}(np-1)} \text{Hypergeometric2F1}\left(\frac{1}{2}, \frac{1}{2}(np + 1), \frac{3}{2}, \cos^2(c + dx)\right) (a(b \csc(c + dx))^p)^n}{d}$$

Antiderivative was successfully verified.

```
[In] Integrate[(a*(b*Csc[c + d*x])^p)^n,x]
```

```
[Out] -((Cos[c + d*x]*(a*(b*Csc[c + d*x])^p)^n*Hypergeometric2F1[1/2, (1 + n*p)/2,
3/2, Cos[c + d*x]^2]*Sin[c + d*x]*(Sin[c + d*x]^2)^((-1 + n*p)/2))/d
```

Maple [F] time = 0.343, size = 0, normalized size = 0.

$$\int (a(b \csc(dx + c))^p)^n dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] int((a*(b*csc(d*x+c))^p)^n,x)
```

```
[Out] int((a*(b*csc(d*x+c))^p)^n,x)
```

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int \left((b \csc(dx + c))^p a \right)^n dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*(b*csc(d*x+c))^p)^n,x, algorithm="maxima")

[Out] integrate(((b*csc(d*x + c))^p*a)^n, x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\left((b \csc(dx + c))^p a\right)^n, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*(b*csc(d*x+c))^p)^n,x, algorithm="fricas")

[Out] integral(((b*csc(d*x + c))^p*a)^n, x)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int \left(a (b \csc(c + dx))^p \right)^n dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*(b*csc(d*x+c)**p)**n,x)

[Out] Integral((a*(b*csc(c + d*x)**p)**n, x)

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int \left((b \csc(dx + c))^p a \right)^n dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate((a*(b*csc(d*x+c))^p)^n,x, algorithm="giac")
```

```
[Out] integrate(((b*csc(d*x + c))^p*a)^n, x)
```

3.70 $\int (a \csc(e + fx))^m (b \csc(e + fx))^n dx$

Optimal. Leaf size=91

$$\frac{a \cos(e + fx)(a \csc(e + fx))^{m-1}(b \csc(e + fx))^n \operatorname{Hypergeometric2F1}\left(\frac{1}{2}, \frac{1}{2}(-m - n + 1), \frac{1}{2}(-m - n + 3), \sin^2(e + fx)\right)}{f(-m - n + 1)\sqrt{\cos^2(e + fx)}}$$

[Out] (a*Cos[e + f*x]*(a*Csc[e + f*x])^(-1 + m)*(b*Csc[e + f*x])^n*Hypergeometric2F1[1/2, (1 - m - n)/2, (3 - m - n)/2, Sin[e + f*x]^2])/(f*(1 - m - n)*Sqrt[Cos[e + f*x]^2])

Rubi [A] time = 0.0448884, antiderivative size = 91, normalized size of antiderivative = 1., number of steps used = 3, number of rules used = 3, integrand size = 21, $\frac{\text{number of rules}}{\text{integrand size}} = 0.143$, Rules used = {20, 3772, 2643}

$$\frac{a \cos(e + fx)(a \csc(e + fx))^{m-1}(b \csc(e + fx))^n {}_2F_1\left(\frac{1}{2}, \frac{1}{2}(-m - n + 1); \frac{1}{2}(-m - n + 3); \sin^2(e + fx)\right)}{f(-m - n + 1)\sqrt{\cos^2(e + fx)}}$$

Antiderivative was successfully verified.

[In] Int[(a*Csc[e + f*x])^m*(b*Csc[e + f*x])^n,x]

[Out] (a*Cos[e + f*x]*(a*Csc[e + f*x])^(-1 + m)*(b*Csc[e + f*x])^n*Hypergeometric2F1[1/2, (1 - m - n)/2, (3 - m - n)/2, Sin[e + f*x]^2])/(f*(1 - m - n)*Sqrt[Cos[e + f*x]^2])

Rule 20

Int[(u_.)*((a_.)*(v_))^(m_)*((b_.)*(v_))^(n_), x_Symbol] := Dist[(b^IntPart[n]*(b*v)^FracPart[n])/(a^IntPart[n]*(a*v)^FracPart[n]), Int[u*(a*v)^(m + n), x], x] /; FreeQ[{a, b, m, n}, x] && !IntegerQ[m] && !IntegerQ[n] && !IntegerQ[m + n]

Rule 3772

Int[(csc[(c_.) + (d_.)*(x_)]*(b_.))^(n_), x_Symbol] := Simp[(b*Csc[c + d*x])^(n - 1)*((Sin[c + d*x]/b)^(n - 1)*Int[1/(Sin[c + d*x]/b)^n, x]), x] /; FreeQ[{b, c, d, n}, x] && !IntegerQ[n]

Rule 2643

```
Int[((b_.)*sin[(c_.) + (d_.)*(x_)])^(n_), x_Symbol] :> Simp[(Cos[c + d*x]*(
b*Sin[c + d*x])^(n + 1)*Hypergeometric2F1[1/2, (n + 1)/2, (n + 3)/2, Sin[c
+ d*x]^2)]/(b*d*(n + 1)*Sqrt[Cos[c + d*x]^2]), x] /; FreeQ[{b, c, d, n}, x]
&& !IntegerQ[2*n]
```

Rubi steps

$$\begin{aligned} \int (a \csc(e + fx))^m (b \csc(e + fx))^n dx &= ((a \csc(e + fx))^{-n} (b \csc(e + fx))^n) \int (a \csc(e + fx))^{m+n} dx \\ &= \left((a \csc(e + fx))^m (b \csc(e + fx))^n \left(\frac{\sin(e + fx)}{a} \right)^{m+n} \right) \int \left(\frac{\sin(e + fx)}{a} \right)^{-m-n} dx \\ &= \frac{\cos(e + fx) (a \csc(e + fx))^m (b \csc(e + fx))^n {}_2F_1\left(\frac{1}{2}, \frac{1}{2}(1 - m - n); \frac{1}{2}(3 - m - n); \sin^2(e + fx)\right)}{f(1 - m - n)\sqrt{\cos^2(e + fx)}} \end{aligned}$$

Mathematica [A] time = 0.140602, size = 77, normalized size = 0.85

$$\frac{\sin(e + fx) \cos(e + fx) (a \csc(e + fx))^m (b \csc(e + fx))^n \sin^2(e + fx)^{\frac{1}{2}(m+n-1)} \text{Hypergeometric2F1}\left(\frac{1}{2}, \frac{1}{2}(m + n + 1), \frac{3}{2}, \sin^2(e + fx)\right)}{f}$$

Antiderivative was successfully verified.

```
[In] Integrate[(a*Csc[e + f*x])^m*(b*Csc[e + f*x])^n,x]
```

```
[Out] -((Cos[e + f*x]*(a*Csc[e + f*x])^m*(b*Csc[e + f*x])^n*Hypergeometric2F1[1/2
, (1 + m + n)/2, 3/2, Cos[e + f*x]^2]*Sin[e + f*x]*(Sin[e + f*x]^2)^((-1 +
m + n)/2))/f)
```

Maple [F] time = 1.082, size = 0, normalized size = 0.

$$\int (a \csc(fx + e))^m (b \csc(fx + e))^n dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] int((a*csc(f*x+e))^m*(b*csc(f*x+e))^n,x)
```

```
[Out] int((a*csc(f*x+e))^m*(b*csc(f*x+e))^n,x)
```

Maxima [F] time = 0., size = 0, normalized size = 0.

$$\int (a \csc (fx + e))^m (b \csc (fx + e))^n dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(f*x+e))^m*(b*csc(f*x+e))^n,x, algorithm="maxima")

[Out] integrate((a*csc(f*x + e))^m*(b*csc(f*x + e))^n, x)

Fricas [F] time = 0., size = 0, normalized size = 0.

$$\text{integral}\left(\left(a \csc (fx + e)\right)^m \left(b \csc (fx + e)\right)^n, x\right)$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(f*x+e))^m*(b*csc(f*x+e))^n,x, algorithm="fricas")

[Out] integral((a*csc(f*x + e))^m*(b*csc(f*x + e))^n, x)

Sympy [F] time = 0., size = 0, normalized size = 0.

$$\int (a \csc (e + fx))^m (b \csc (e + fx))^n dx$$

Verification of antiderivative is not currently implemented for this CAS.

[In] integrate((a*csc(f*x+e))**m*(b*csc(f*x+e))**n,x)

[Out] Integral((a*csc(e + f*x))**m*(b*csc(e + f*x))**n, x)

Giac [F] time = 0., size = 0, normalized size = 0.

$$\int (a \csc (fx + e))^m (b \csc (fx + e))^n dx$$

Verification of antiderivative is not currently implemented for this CAS.

```
[In] integrate((a*csc(f*x+e))^m*(b*csc(f*x+e))^n,x, algorithm="giac")
```

```
[Out] integrate((a*csc(f*x + e))^m*(b*csc(f*x + e))^n, x)
```


Chapter 4

Listing of Grading functions

The following are the current version of the grading functions used for grading the quality of the antiderivative with reference to the optimal antiderivative included in the test suite.

There is a version for Maple and for Mathematica/Rubi. There is a version for grading Sympy and version for use with Sagemath.

The following are links to the current source code.

The following are the listings of source code of the grading functions.

4.0.1 Mathematica and Rubi grading function

```
1 (* Original version thanks to Albert Rich emailed on 03/21/2017 *)
2 (* ::Package:: *)
3
4 (* ::Subsection:: *)
5 (*GradeAntiderivative[result,optimal]*)
6
7
8 (* ::Text:: *)
9 (*If result and optimal are mathematical expressions, *)
10 (*      GradeAntiderivative[result,optimal] returns*)
11 (* "F" if the result fails to integrate an expression that*)
12 (*      is integrable*)
13 (* "C" if result involves higher level functions than necessary*)
14 (* "B" if result is more than twice the size of the optimal*)
15 (*      antiderivative*)
16 (* "A" if result can be considered optimal*)
17
18
19 GradeAntiderivative[result_,optimal_] :=
20   If[ExpnType[result]<=ExpnType[optimal],
21     If[FreeQ[result,Complex] || Not[FreeQ[optimal,Complex]],
```

```

22     If[LeafCount[result]<=2*LeafCount[optimal],
23         "A",
24         "B"],
25     "C"],
26 If[FreeQ[result,Integrate] && FreeQ[result,Int],
27     "C",
28     "F"]]
29
30
31 (* ::Text:: *)
32 (*The following summarizes the type number assigned an *)
33 (*expression based on the functions it involves*)
34 (*1 = rational function*)
35 (*2 = algebraic function*)
36 (*3 = elementary function*)
37 (*4 = special function*)
38 (*5 = hyperpergeometric function*)
39 (*6 = appell function*)
40 (*7 = rootsum function*)
41 (*8 = integrate function*)
42 (*9 = unknown function*)
43
44
45 ExpnType[expn_] :=
46   If[AtomQ[expn],
47     1,
48     If[ListQ[expn],
49       Max[Map[ExpnType,expn]],
50       If[Head[expn]===Power,
51         If[IntegerQ[expn[[2]]],
52           ExpnType[expn[[1]]],
53         If[Head[expn[[2]]]===Rational,
54           If[IntegerQ[expn[[1]]] || Head[expn[[1]]]===Rational,
55             1,
56             Max[ExpnType[expn[[1]],2]],
57           Max[ExpnType[expn[[1]],ExpnType[expn[[2]],3]],
58         If[Head[expn]===Plus || Head[expn]===Times,
59           Max[ExpnType[First[expn]],ExpnType[Rest[expn]]],
60         If[ElementaryFunctionQ[Head[expn]],
61           Max[3,ExpnType[expn[[1]]],
62         If[SpecialFunctionQ[Head[expn]],
63           Apply[Max,Append[Map[ExpnType,Apply[List,expn]],4]],
64         If[HypergeometricFunctionQ[Head[expn]],
65           Apply[Max,Append[Map[ExpnType,Apply[List,expn]],5]],
66         If[AppellFunctionQ[Head[expn]],
67           Apply[Max,Append[Map[ExpnType,Apply[List,expn]],6]],
68         If[Head[expn]===RootSum,

```

```

69   Apply[Max, Append[Map[ExpnType, Apply[List, expn]], 7]],
70   If[Head[expn]===Integrate || Head[expn]===Int,
71     Apply[Max, Append[Map[ExpnType, Apply[List, expn]], 8]],
72   9]]]]]]]]]]
73
74
75 ElementaryFunctionQ[func_] :=
76   MemberQ[{
77     Exp, Log,
78     Sin, Cos, Tan, Cot, Sec, Csc,
79     ArcSin, ArcCos, ArcTan, ArcCot, ArcSec, ArcCsc,
80     Sinh, Cosh, Tanh, Coth, Sech, Csch,
81     ArcSinh, ArcCosh, ArcTanh, ArcCoth, ArcSech, ArcCsch
82   }, func]
83
84
85 SpecialFunctionQ[func_] :=
86   MemberQ[{
87     Erf, Erfc, Erfi,
88     FresnelS, FresnelC,
89     ExpIntegralE, ExpIntegralEi, LogIntegral,
90     SinIntegral, CosIntegral, SinhIntegral, CoshIntegral,
91     Gamma, LogGamma, PolyGamma,
92     Zeta, PolyLog, ProductLog,
93     EllipticF, EllipticE, EllipticPi
94   }, func]
95
96
97 HypergeometricFunctionQ[func_] :=
98   MemberQ[{Hypergeometric1F1, Hypergeometric2F1, HypergeometricPFQ}, func]
99
100
101 AppellFunctionQ[func_] :=
102   MemberQ[{AppellF1}, func]

```

4.0.2 Maple grading function

```

1 # File: GradeAntiderivative.mpl
2 # Original version thanks to Albert Rich emailed on 03/21/2017
3
4 #Nasser 03/22/2017 Use Maple leaf count instead since buildin
5 #Nasser 03/23/2017 missing 'ln' for ElementaryFunctionQ added
6 #Nasser 03/24/2017 corrected the check for complex result
7 #Nasser 10/27/2017 check for leafsize and do not call ExpnType()
8 #
9 #Nasser 12/22/2019 Added debug flag, added 'dilog' to special functions
10 #
11 see problem 156, file Apostol_Problems

```

```

11
12 GradeAntiderivative := proc(result,optimal)
13 local leaf_count_result, leaf_count_optimal,ExpnType_result,ExpnType_optimal,
    debug:=false;
14
15     leaf_count_result:=leafcount(result);
16     #do NOT call ExpnType() if leaf size is too large. Recursion problem
17     if leaf_count_result > 500000 then
18         return "B";
19     fi;
20
21     leaf_count_optimal:=leafcount(optimal);
22
23     ExpnType_result:=ExpnType(result);
24     ExpnType_optimal:=ExpnType(optimal);
25
26     if debug then
27         print("ExpnType_result",ExpnType_result," ExpnType_optimal=",
    ExpnType_optimal);
28     fi;
29
30 # If result and optimal are mathematical expressions,
31 # GradeAntiderivative[result,optimal] returns
32 #   "F" if the result fails to integrate an expression that
33 #     is integrable
34 #   "C" if result involves higher level functions than necessary
35 #   "B" if result is more than twice the size of the optimal
36 #     antiderivative
37 #   "A" if result can be considered optimal
38
39 #This check below actually is not needed, since I only
40 #call this grading only for passed integrals. i.e. I check
41 #for "F" before calling this. But no harm of keeping it here.
42 #just in case.
43
44
45 if not type(result,freeof('int')) then
46     return "F";
47 end if;
48
49
50 if ExpnType_result<=ExpnType_optimal then
51     if debug then
52         print("ExpnType_result<=ExpnType_optimal");
53     fi;
54     if is_contains_complex(result) then
55         if is_contains_complex(optimal) then

```

```

56     if debug then
57         print("both result and optimal complex");
58     fi;
59     #both result and optimal complex
60     if leaf_count_result<=2*leaf_count_optimal then
61         return "A";
62     else
63         return "B";
64     end if
65     else #result contains complex but optimal is not
66         if debug then
67             print("result contains complex but optimal is not");
68         fi;
69         return "C";
70     end if
71     else # result do not contain complex
72         # this assumes optimal do not as well
73         if debug then
74             print("result do not contain complex, this assumes optimal do not
as well");
75         fi;
76         if leaf_count_result<=2*leaf_count_optimal then
77             if debug then
78                 print("leaf_count_result<=2*leaf_count_optimal");
79             fi;
80             return "A";
81         else
82             if debug then
83                 print("leaf_count_result>2*leaf_count_optimal");
84             fi;
85             return "B";
86         end if
87     end if
88     else #ExpnType(result) > ExpnType(optimal)
89         if debug then
90             print("ExpnType(result) > ExpnType(optimal)");
91         fi;
92         return "C";
93     end if
94
95 end proc:
96
97 #
98 # is_contains_complex(result)
99 # takes expressions and returns true if it contains "I" else false
100 #
101 #Nasser 032417

```

```

102 is_contains_complex:= proc(expression)
103   return (has(expression,I));
104 end proc:
105
106 # The following summarizes the type number assigned an expression
107 # based on the functions it involves
108 # 1 = rational function
109 # 2 = algebraic function
110 # 3 = elementary function
111 # 4 = special function
112 # 5 = hyperpergeometric function
113 # 6 = appell function
114 # 7 = rootsum function
115 # 8 = integrate function
116 # 9 = unknown function
117
118 ExpnType := proc(expn)
119   if type(expn,'atomic') then
120     1
121   elif type(expn,'list') then
122     apply(max,map(ExpnType,expn))
123   elif type(expn,'sqrt') then
124     if type(op(1,expn),'rational') then
125       1
126     else
127       max(2,ExpnType(op(1,expn)))
128     end if
129   elif type(expn,'^^') then
130     if type(op(2,expn),'integer') then
131       ExpnType(op(1,expn))
132     elif type(op(2,expn),'rational') then
133       if type(op(1,expn),'rational') then
134         1
135       else
136         max(2,ExpnType(op(1,expn)))
137       end if
138     else
139       max(3,ExpnType(op(1,expn)),ExpnType(op(2,expn)))
140     end if
141   elif type(expn,'^+^') or type(expn,'`*`') then
142     max(ExpnType(op(1,expn)),max(ExpnType(rest(expn))))
143   elif ElementaryFunctionQ(op(0,expn)) then
144     max(3,ExpnType(op(1,expn)))
145   elif SpecialFunctionQ(op(0,expn)) then
146     max(4,apply(max,map(ExpnType,[op(expn)])))
147   elif HypergeometricFunctionQ(op(0,expn)) then
148     max(5,apply(max,map(ExpnType,[op(expn)])))

```

```

149   elif AppellFunctionQ(op(0,expn)) then
150       max(6,apply(max,map(ExpnType,[op(expn)])))
151   elif op(0,expn)='int' then
152       max(8,apply(max,map(ExpnType,[op(expn)]))) else
153       9
154   end if
155 end proc:
156
157 ElementaryFunctionQ := proc(func)
158     member(func,[
159         exp,log,ln,
160         sin,cos,tan,cot,sec,csc,
161         arcsin,arccos,arctan,arccot,arcsec,arccsc,
162         sinh,cosh,tanh,coth,sech,csch,
163         arcsinh,arccosh,arctanh,arccoth,arcsech,arccsch])
164 end proc:
165
166 SpecialFunctionQ := proc(func)
167     member(func,[
168         erf,erfc,erfi,
169         FresnelS,FresnelC,
170         Ei,Ei,Li,Si,Ci,Shi,Chi,
171         GAMMA,lnGAMMA,Psi,Zeta,polylog,dilog,LambertW,
172         EllipticF,EllipticE,EllipticPi])
173 end proc:
174
175 HypergeometricFunctionQ := proc(func)
176     member(func,[Hypergeometric1F1,hypergeom,HypergeometricPFQ])
177 end proc:
178
179 AppellFunctionQ := proc(func)
180     member(func,[AppellF1])
181 end proc:
182
183 # u is a sum or product. rest(u) returns all but the
184 # first term or factor of u.
185 rest := proc(u) local v;
186     if nops(u)=2 then
187         op(2,u)
188     else
189         apply(op(0,u),op(2..nops(u),u))
190     end if
191 end proc:
192
193 #leafcount(u) returns the number of nodes in u.
194 #Nasser 3/23/17 Replaced by build-in leafCount from package in Maple

```

```

196 leafcount := proc(u)
197     MmaTranslator[Mma][LeafCount](u);
198 end proc:

```

4.0.3 Sympy grading function

```

1 #Dec 24, 2019. Nasser M. Abbasi:
2 #           Port of original Maple grading function by
3 #           Albert Rich to use with Sympy/Python
4 #Dec 27, 2019 Nasser. Added `RootSum`. See problem 177, Timofeev file
5 #           added 'exp_polar'
6 from sympy import *
7
8 def leaf_count(expr):
9     #sympy do not have leaf count function. This is approximation
10    return round(1.7*count_ops(expr))
11
12 def is_sqrt(expr):
13     if isinstance(expr,Pow):
14         if expr.args[1] == Rational(1,2):
15             return True
16         else:
17             return False
18     else:
19         return False
20
21 def is_elementary_function(func):
22     return func in [exp,log,ln,sin,cos,tan,cot,sec,csc,
23                    asin,acos,atan,acot,asec,acsc,sinh,cosh,tanh,coth,sech,csch,
24                    asinh,acosh,atanh,acoth,asech,acsch
25                    ]
26
27 def is_special_function(func):
28     return func in [ erf,erfc,erfi,
29                    fresnels,fresnelc,Ei,Ei,Li,Si,Ci,Shi,Chi,
30                    gamma,loggamma,digamma,zeta,polylog,LambertW,
31                    elliptic_f,elliptic_e,elliptic_pi,exp_polar
32                    ]
33
34 def is_hypergeometric_function(func):
35     return func in [hyper]
36
37 def is_appell_function(func):
38     return func in [appellf1]
39
40 def is_atom(expn):
41     try:

```



```

42     if expn.isAtom or isinstance(expn,int) or isinstance(expn,float):
43         return True
44     else:
45         return False
46
47     except AttributeError as error:
48         return False
49
50 def expnType(expn):
51     debug=False
52     if debug:
53         print("expn=",expn,"type(expn)=",type(expn))
54
55     if is_atom(expn):
56         return 1
57     elif isinstance(expn,list):
58         return max(map(expnType, expn)) #apply(max,map(ExpnType,expn))
59     elif is_sqrt(expn):
60         if isinstance(expn.args[0],Rational): #type(op(1,expn),'rational')
61             return 1
62         else:
63             return max(2,expnType(expn.args[0])) #max(2,ExpnType(op(1,expn)))
64     elif isinstance(expn,Pow): #type(expn,'^^')
65         if isinstance(expn.args[1],Integer): #type(op(2,expn),'integer')
66             return expnType(expn.args[0]) #ExpnType(op(1,expn))
67         elif isinstance(expn.args[1],Rational): #type(op(2,expn),'rational')
68             if isinstance(expn.args[0],Rational): #type(op(1,expn),'rational')
69                 return 1
70             else:
71                 return max(2,expnType(expn.args[0])) #max(2,ExpnType(op(1,expn)
72 ))
73     else:
74         return max(3,expnType(expn.args[0]),expnType(expn.args[1])) #max(3,
75 ExpnType(op(1,expn)),ExpnType(op(2,expn)))
76     elif isinstance(expn,Add) or isinstance(expn,Mul): #type(expn,'+' or type
77 (expn,'*')
78         m1 = expnType(expn.args[0])
79         m2 = expnType(list(expn.args[1:]))
80         return max(m1,m2) #max(ExpnType(op(1,expn)),max(ExpnType(rest(expn))))
81     elif is_elementary_function(expn.func): #ElementaryFunctionQ(op(0,expn))
82         return max(3,expnType(expn.args[0])) #max(3,ExpnType(op(1,expn)))
83     elif is_special_function(expn.func): #SpecialFunctionQ(op(0,expn))
84         m1 = max(map(expnType, list(expn.args)))
85         return max(4,m1) #max(4,apply(max,map(ExpnType,[op(expn)])))
86     elif is_hypergeometric_function(expn.func): #HypergeometricFunctionQ(op(0,
87 expn))
88         m1 = max(map(expnType, list(expn.args)))

```

```

85     return max(5,m1)    #max(5,apply(max,map(ExpnType,[op(expn)])))
86 elif is_appell_function(expn.func):
87     m1 = max(map(expnType, list(expn.args)))
88     return max(6,m1)    #max(5,apply(max,map(ExpnType,[op(expn)])))
89 elif isinstance(expn,RootSum):
90     m1 = max(map(expnType, list(expn.args))) #Apply[Max,Append[Map[ExpnType,
Apply[List,expn]],7]],
91     return max(7,m1)
92 elif str(expn).find("Integral") != -1:
93     m1 = max(map(expnType, list(expn.args)))
94     return max(8,m1)    #max(5,apply(max,map(ExpnType,[op(expn)])))
95 else:
96     return 9
97
98 #main function
99 def grade_antiderivative(result,optimal):
100
101     leaf_count_result  = leaf_count(result)
102     leaf_count_optimal = leaf_count(optimal)
103
104     expnType_result  = expnType(result)
105     expnType_optimal = expnType(optimal)
106
107     if str(result).find("Integral") != -1:
108         return "F"
109
110     if expnType_result <= expnType_optimal:
111         if result.has(I):
112             if optimal.has(I): #both result and optimal complex
113                 if leaf_count_result <= 2*leaf_count_optimal:
114                     return "A"
115                 else:
116                     return "B"
117             else: #result contains complex but optimal is not
118                 return "C"
119         else: # result do not contain complex, this assumes optimal do not as
well
120             if leaf_count_result <= 2*leaf_count_optimal:
121                 return "A"
122             else:
123                 return "B"
124     else:
125         return "C"

```

4.0.4 SageMath grading function

1 #Dec 24, 2019. Nasser: Ported original Maple grading function by

```

2 #           Albert Rich to use with Sagemath. This is used to
3 #           grade Fracas, Giac and Maxima results.
4 #Dec 24, 2019. Nasser: Added 'exp_integral_e' and 'sng', 'sin_integral'
5 #           'arctan2','floor','abs','log_integral'
6
7 from sage.all import *
8 from sage.symbolic.operators import add_vararg, mul_vararg
9
10 def tree(expr):
11     debug=False;
12     if debug:
13         print ("Enter tree(expr), expr=",expr)
14         print ("expr.operator()=",expr.operator())
15         print ("expr.operands()=",expr.operands())
16         print ("map(tree, expr.operands()=",map(tree, expr.operands()))
17
18     if expr.operator() is None:
19         return expr
20     else:
21         return [expr.operator()+list(map(tree, expr.operands()))
22
23 def leaf_count(anti):
24     debug=False;
25
26     if debug: print ("Enter leaf_count, anti=", anti, " len(anti)=", len(anti))
27
28     if len(anti) == 0: #special check for optimal being 0 for some test cases.
29         if debug: print ("len(anti) == 0")
30         return 1
31     else:
32         if debug: print ("round(1.35*len(flatten(tree(anti))))=",round(1.35*len(
33         flatten(tree(anti))))
34         return round(1.35*len(flatten(tree(anti)))) #fudge factor
35         #since this estimate of leaf count is bit lower than
36         #what it should be compared to Mathematica's
37
38 def is_sqrt(expr):
39     debug=False;
40     if expr.operator() == operator.pow: #isinstance(expr,Pow):
41         if expr.operands()[1]==1/2: #expr.args[1] == Rational(1,2):
42             if debug: print ("expr is sqrt")
43             return True
44         else:
45             return False
46     else:
47         return False

```

```

48 def is_elementary_function(func):
49     debug = False
50
51     m = func.name() in ['exp','log','ln',
52         'sin','cos','tan','cot','sec','csc',
53         'arcsin','arccos','arctan','arccot','arcsec','arccsc',
54         'sinh','cosh','tanh','coth','sech','csch',
55         'arcsinh','arccosh','arctanh','arccoth','arcsech','arccsch','sgn',
56         'arctan2','floor','abs'
57     ]
58     if debug:
59         if m:
60             print ("func ", func , " is elementary_function")
61         else:
62             print ("func ", func , " is NOT elementary_function")
63
64
65     return m
66
67 def is_special_function(func):
68     debug = False
69
70     if debug: print ("type(func)=", type(func))
71
72     m= func.name() in ['erf','erfc','erfi','fresnel_sin','fresnel_cos','Ei',
73         'Ei','Li','Si','sin_integral','Ci','cos_integral','Shi','
74     sinh_integral'
75         'Chi','cosh_integral','gamma','log_gamma','psi,zeta',
76         'polylog','lambert_w','elliptic_f','elliptic_e',
77         'elliptic_pi','exp_integral_e','log_integral']
78
79     if debug:
80         print ("m=",m)
81         if m:
82             print ("func ", func ," is special_function")
83         else:
84             print ("func ", func ," is NOT special_function")
85
86     return m
87
88
89 def is_hypergeometric_function(func):
90     return func.name() in ['hypergeometric','hypergeometric_M','hypergeometric_U
91     ']
92
93 def is_appell_function(func):

```

```

93     return func.name() in ['hypergeometric']    #[appellf1] can't find this in
          sagemath
94
95 def is_atom(expn):
96
97     #thanks to answer at https://ask.sagemath.org/question/49179/what-is-sagemath-equivalent-to-atomic-type-in-maple/
98     try:
99         if expn.parent() is SR:
100             return expn.operator() is None
101         if expn.parent() in (ZZ, QQ, AA, QQbar):
102             return expn in expn.parent() # Should always return True
103         if hasattr(expn.parent(),"base_ring") and hasattr(expn.parent(),"gens"):
104             return expn in expn.parent().base_ring() or expn in expn.parent().
          gens()
105         return False
106
107     except AttributeError as error:
108         return False
109
110
111 def expnType(expn):
112     debug=False
113
114     if debug:
115         print(">>>>Enter expnType, expn=", expn)
116         print(">>>>is_atom(expn)=", is_atom(expn))
117
118     if is_atom(expn):
119         return 1
120     elif type(expn)==list:    #isinstance(expn,list):
121         return max(map(expnType, expn))    #apply(max,map(ExpnType,expn))
122     elif is_sqrt(expn):
123         if type(expn.operands()[0])==Rational: #type(isinstance(expn.args[0],
          Rational):
124             return 1
125         else:
126             return max(2,expnType(expn.operands()[0]))    #max(2,expnType(expn.
          args[0]))
127     elif expn.operator() == operator.pow:    #isinstance(expn,Pow)
128         if type(expn.operands()[1])==Integer:    #isinstance(expn.args[1],Integer)
129             return expnType(expn.operands()[0])    #expnType(expn.args[0])
130         elif type(expn.operands()[1])==Rational:    #isinstance(expn.args[1],
          Rational)
131             if type(expn.operands()[0])==Rational: #isinstance(expn.args[0],
          Rational)
132                 return 1

```

```

133         else:
134             return max(2,expnType(expn.operands()[0])) #max(2,expnType(expn.
args[0]))
135         else:
136             return max(3,expnType(expn.operands()[0]),expnType(expn.operands()
[1])) #max(3,expnType(expn.operands()[0]),expnType(expn.operands()[1]))
137         elif expn.operator() == add_vararg or expn.operator() == mul_vararg: #
isinstance(expn,Add) or isinstance(expn,Mul)
138             m1 = expnType(expn.operands()[0]) #expnType(expn.args[0])
139             m2 = expnType(expn.operands()[1:]) #expnType(list(expn.args[1:]))
140             return max(m1,m2) #max(ExpnType(op(1,expn)),max(ExpnType(rest(expn)))
141         elif is_elementary_function(expn.operator()): #is_elementary_function(expn.
func)
142             return max(3,expnType(expn.operands()[0]))
143         elif is_special_function(expn.operator()): #is_special_function(expn.func)
144             m1 = max(map(expnType, expn.operands())) #max(map(expnType, list(
expn.args)))
145             return max(4,m1) #max(4,m1)
146         elif is_hypergeometric_function(expn.operator()): #
is_hypergeometric_function(expn.func)
147             m1 = max(map(expnType, expn.operands())) #max(map(expnType, list(
expn.args)))
148             return max(5,m1) #max(5,m1)
149         elif is_appell_function(expn.operator()):
150             m1 = max(map(expnType, expn.operands())) #max(map(expnType, list(
expn.args)))
151             return max(6,m1) #max(6,m1)
152         elif str(expn).find("Integral") != -1: #this will never happen, since it
153             #is checked before calling the grading function that is passed.
154             #but kept it here.
155             m1 = max(map(expnType, expn.operands())) #max(map(expnType, list(
expn.args)))
156             return max(8,m1) #max(5,apply(max,map(ExpnType,[op(expn)])))
157         else:
158             return 9
159
160 #main function
161 def grade_antiderivative(result,optimal):
162     debug = False;
163
164     if debug: print ("Enter grade_antiderivative for sagemath")
165
166     leaf_count_result = leaf_count(result)
167     leaf_count_optimal = leaf_count(optimal)
168
169     if debug: print ("leaf_count_result=", leaf_count_result, "
leaf_count_optimal=",leaf_count_optimal)

```

```
170
171
172     expnType_result = expnType(result)
173     expnType_optimal = expnType(optimal)
174
175     if debug: print ("expnType_result=", expnType_result, "expnType_optimal=",
176                     expnType_optimal)
177
178     if expnType_result <= expnType_optimal:
179         if result.has(I):
180             if optimal.has(I): #both result and optimal complex
181                 if leaf_count_result <= 2*leaf_count_optimal:
182                     return "A"
183                 else:
184                     return "B"
185             else: #result contains complex but optimal is not
186                 return "C"
187         else: # result do not contain complex, this assumes optimal do not as
188             well
189                 if leaf_count_result <= 2*leaf_count_optimal:
190                     return "A"
191                 else:
192                     return "B"
193     else:
194         return "C"
```