Rules for integrands of the form $(f\,x)^m\,(d+e\,x^2)^q\,(a+b\,x^2+c\,x^4)^p$

1. $\int (f\,x)^m\,(e\,x^2)^q\,(a+b\,x^2+c\,x^4)^p\,dx$

x: $\int (f\,x)^m\,(e\,x^2)^q\,(a+b\,x^2+c\,x^4)^p\,dx$ when $m\in\mathbb{Z}$

- **Derivation: Algebraic simplification**
- **Basis: If $m\in\mathbb{Z}$, then $(e\,x^2)^q == \frac{e^q}{f^{2q}}\,(f\,x)^{2q}$**
- **Rule 1.2.2.4.1.1: If $m\in\mathbb{Z}$, then**

$$\int (f\,x)^m\,(e\,x^2)^q\,(a+b\,x^2+c\,x^4)^p\,dx \longrightarrow \frac{e^q}{f^{2q}}\int (f\,x)^{m+2q}\,(a+b\,x^2+c\,x^4)^p\,dx$$

- **Program code:**

```
(* Int[(f_.*x_)^m_.*(e_.*x_^2)^q_.*(a_+b_.*x_^2+c_.*x_^4)^p_.,x_Symbol] :=
  e^q/f^(2*q)*Int[(f*x)^(m+2*q)*(a+b*x^2+c*x^4)^p,x] /;
FreeQ[{a,b,c,e,f,m,p},x] && IntegerQ[q] *)
```

```
(* Int[(f_.*x_)^m_.*(e_.*x_^2)^q_.*(a_+c_.*x_^4)^p_.,x_Symbol] :=
  e^q/f^(2*q)*Int[(f*x)^(m+2*q)*(a+c*x^4)^p,x] /;
FreeQ[{a,c,e,f,m,p},x] && IntegerQ[q] *)
```

2. $\int (f x)^m \left(e x^2\right)^q \left(a+b x^2+c x^4\right)^p dx$ when $q \notin \mathbb{Z}$

1: $\int x^m \left(e x^2\right)^q \left(a+b x^2+c x^4\right)^p dx$ when $q \notin \mathbb{Z} \bigwedge \frac{m-1}{2} \in \mathbb{Z}$

- **Derivation: Integration by substitution**
- **Basis: If $\frac{m-1}{2} \in \mathbb{Z}$, then $x^m \left(e x^2\right)^q == \frac{1}{e^{\frac{m-1}{2}}} x \left(e x^2\right)^{q+\frac{m-1}{2}}$**
- **Basis: $x F\left[x^2\right] == \frac{1}{2} \text{Subst}\left[F[x],\, x,\, x^2\right] \partial_x x^2$**
- **Rule 1.2.2.4.1.2.1: If $q \notin \mathbb{Z} \bigwedge \frac{m-1}{2} \in \mathbb{Z}$, then**

$$\int x^m \left(e x^2\right)^q \left(a+b x^2+c x^4\right)^p dx \longrightarrow \frac{1}{2 e^{\frac{m-1}{2}}} \text{Subst}\left[\int (e x)^{q+\frac{m-1}{2}} \left(a+b x+c x^2\right)^p dx,\, x,\, x^2\right]$$

- **Program code:**

```
Int[x_^m_.*(e_.*x_^2)^q_*(a_+b_.*x_^2+c_.*x_^4)^p_.,x_Symbol] :=
  1/(2*e^((m-1)/2))*Subst[Int[(e*x)^(q+(m-1)/2)*(a+b*x+c*x^2)^p,x],x,x^2] /;
FreeQ[{a,b,c,e,p,q},x] && Not[IntegerQ[q]] && IntegerQ[(m-1)/2]
```

```
Int[x_^m_.*(e_.*x_^2)^q_*(a_+c_.*x_^4)^p_.,x_Symbol] :=
  1/(2*e^((m-1)/2))*Subst[Int[(e*x)^(q+(m-1)/2)*(a+c*x^2)^p,x],x,x^2] /;
FreeQ[{a,c,e,p,q},x] && Not[IntegerQ[q]] && IntegerQ[(m-1)/2]
```

2: $\int (f\,x)^m \left(e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p dx$ when $q \notin \mathbb{Z}$

Derivation: Piecewise constant extraction

- Basis: $\partial_x \frac{(e\,x^2)^q}{(f\,x)^{2q}} == 0$

- Rule 1.2.2.4.1.2.2: If $q \notin \mathbb{Z}$, then

$$\int (f\,x)^m \left(e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p dx \longrightarrow \frac{e^{\text{IntPart}[q]} \left(e\,x^2\right)^{\text{FracPart}[q]}}{f^{2\,\text{IntPart}[q]} (f\,x)^{2\,\text{FracPart}[q]}} \int (f\,x)^{m+2q} \left(a+b\,x^2+c\,x^4\right)^p dx$$

- Program code:

```
Int[(f_.*x_)^m_.*(e_.*x_^2)^q_*(a_+b_.*x_^2+c_.*x_^4)^p_.,x_Symbol] :=
  e^IntPart[q]*(e*x^2)^FracPart[q]/(f^(2*IntPart[q])*(f*x)^(2*FracPart[q]))*Int[(f*x)^(m+2*q)*(a+b*x^2+c*x^4)^p,x] /;
FreeQ[{a,b,c,e,f,m,p,q},x] && Not[IntegerQ[q]]
```

```
Int[(f_.*x_)^m_.*(e_.*x_^2)^q_*(a_+c_.*x_^4)^p_.,x_Symbol] :=
  e^IntPart[q]*(e*x^2)^FracPart[q]/(f^(2*IntPart[q])*(f*x)^(2*FracPart[q]))*Int[(f*x)^(m+2*q)*(a+c*x^4)^p,x] /;
FreeQ[{a,c,e,f,m,p,q},x] && Not[IntegerQ[q]]
```

2: $\int x \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p dx$

- Derivation: Integration by substitution

- Basis: $x\,F\left[x^2\right] == \frac{1}{2}\,\text{Subst}\left[F[x],\,x,\,x^2\right] \partial_x x^2$

- Rule 1.2.2.4.2:

$$\int x \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p dx \longrightarrow \frac{1}{2}\,\text{Subst}\left[\int (d+e\,x)^q \left(a+b\,x+c\,x^2\right)^p dx,\,x,\,x^2\right]$$

- Program code:

```
Int[x_*(d_+e_.*x_^2)^q_.*(a_+b_.*x_^2+c_.*x_^4)^p_.,x_Symbol] :=
  1/2*Subst[Int[(d+e*x)^q*(a+b*x+c*x^2)^p,x],x,x^2] /;
FreeQ[{a,b,c,d,e,p,q},x]
```

```
Int[x_*(d_+e_.*x_^2)^q_.*(a_+c_.*x_^4)^p_.,x_Symbol] :=
  1/2*Subst[Int[(d+e*x)^q*(a+c*x^2)^p,x],x,x^2] /;
FreeQ[{a,c,d,e,p,q},x]
```

3. $\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p \,dx$ when $b^2-4\,a\,c=0$

x: $\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p \,dx$ when $b^2-4\,a\,c=0\,\wedge\,p\in\mathbb{Z}$

Derivation: Algebraic simplification

- **Basis: If** $b^2-4\,a\,c=0$**, then** $a+b\,z+c\,z^2=\frac{1}{c}\left(\frac{b}{2}+c\,z\right)^2$

Rule 1.2.2.4.3.1: If $b^2-4\,a\,c=0\,\wedge\,p\in\mathbb{Z}$**, then**

$$\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p \,dx \longrightarrow \frac{1}{c^p}\int (f\,x)^m \left(d+e\,x^2\right)^q \left(\frac{b}{2}+c\,x^2\right)^{2\,p} dx$$

Program code:

```
(* Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_.*(a_+b_.*x_^2+c_.*x_^4)^p_.,x_Symbol] :=
  1/c^p*Int[(f*x)^m*(d+e*x^2)^q*(b/2+c*x^2)^(2*p),x] /;
FreeQ[{a,b,c,d,e,f,m,p,q},x] && EqQ[b^2-4*a*c,0] && IntegerQ[p] *)
```

2. $\int (f\,x)^m\,(d+e\,x^2)^q\,(a+b\,x^2+c\,x^4)^p\,dx$ when $b^2-4\,a\,c==0\,\wedge\,p\notin\mathbb{Z}$

1: $\int x^m\,(d+e\,x^2)^q\,(a+b\,x^2+c\,x^4)^p\,dx$ when $b^2-4\,a\,c==0\,\bigwedge\,p\notin\mathbb{Z}\,\bigwedge\,\frac{m+1}{2}\in\mathbb{Z}^+$

Derivation: Integration by substitution

- **Basis: If $\frac{m+1}{2}\in\mathbb{Z}$, then $x^m\,F\left[x^2\right]==\frac{1}{2}\,\text{Subst}\left[x^{\frac{m-1}{2}}\,F[x],\,x,\,x^2\right]\,\partial_x x^2$**
- **Note: If this substitution rule is applied when $m\in\mathbb{Z}^-$, expressions of the form $\text{Log}\left[x^2\right]$ rather than $\text{Log}[x]$ may appear in the antiderivative.**
- **Rule 1.2.2.4.3.2.1: If $b^2-4\,a\,c==0\,\bigwedge\,p\notin\mathbb{Z}\,\bigwedge\,\frac{m+1}{2}\in\mathbb{Z}^+$, then**

$$\int x^m\,(d+e\,x^2)^q\,(a+b\,x^2+c\,x^4)^p\,dx\,\longrightarrow\,\frac{1}{2}\,\text{Subst}\left[\int x^{\frac{m-1}{2}}\,(d+e\,x)^q\,(a+b\,x+c\,x^2)^p\,dx,\,x,\,x^2\right]$$

Program code:

```
Int[x_^m_.*(d_+e_.*x_^2)^q_.*(a_+b_.*x_^2+c_.*x_^4)^p_,x_Symbol] :=
  1/2*Subst[Int[x^((m-1)/2)*(d+e*x)^q*(a+b*x+c*x^2)^p,x],x,x^2] /;
FreeQ[{a,b,c,d,e,p,q},x] && EqQ[b^2-4*a*c,0] && Not[IntegerQ[p]] && IGtQ[(m+1)/2,0]
```

2: $\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p\,dx$ when $b^2-4\,a\,c==0\,\wedge\,p\notin\mathbb{Z}$

Derivation: Piecewise constant extraction

- **Basis: If** $b^2-4\,a\,c==0$**, then** $\partial_x \frac{(a+b\,x^2+c\,x^4)^p}{\left(\frac{b}{2}+c\,x^2\right)^{2p}}==0$
- **Basis: If** $b^2-4\,a\,c==0$**, then** $\frac{(a+b\,x^2+c\,x^4)^p}{\left(\frac{b}{2}+c\,x^2\right)^{2p}}==\frac{(a+b\,x^2+c\,x^4)^{\text{FracPart}[p]}}{c^{\text{IntPart}[p]}\left(\frac{b}{2}+c\,x^2\right)^{2\,\text{FracPart}[p]}}$
- **Rule 1.2.2.4.3.2.2: If** $b^2-4\,a\,c==0\,\wedge\,p\notin\mathbb{Z}$**, then**

$$\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p\,dx \longrightarrow \frac{\left(a+b\,x^2+c\,x^4\right)^{\text{FracPart}[p]}}{c^{\text{IntPart}[p]}\left(\frac{b}{2}+c\,x^2\right)^{2\,\text{FracPart}[p]}}\int (f\,x)^m \left(d+e\,x^2\right)^q \left(\frac{b}{2}+c\,x^2\right)^{2p} dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_.*(a_+b_.*x_^2+c_.*x_^4)^p_,x_Symbol] :=
  (a+b*x^2+c*x^4)^FracPart[p]/(c^IntPart[p]*(b/2+c*x^2)^(2*FracPart[p]))*
    Int[(f*x)^m*(d+e*x^2)^q*(b/2+c*x^2)^(2*p),x] /;
FreeQ[{a,b,c,d,e,f,m,p,q},x] && EqQ[b^2-4*a*c,0] && Not[IntegerQ[p]]
```

4: $\int x^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p\,dx$ when $\frac{m-1}{2}\in\mathbb{Z}$

Derivation: Integration by substitution

- **Basis: If** $\frac{m-1}{2}\in\mathbb{Z}$**, then** $x^m\,F\left[x^2\right]==\frac{1}{2}\,\text{Subst}\left[x^{\frac{m-1}{2}}\,F[x],\,x,\,x^2\right]\partial_x x^2$
- **Rule 1.2.2.4.4.: If** $\frac{m-1}{2}\in\mathbb{Z}$**, then**

$$\int x^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p\,dx \longrightarrow \frac{1}{2}\,\text{Subst}\left[\int x^{\frac{m-1}{2}}\,(d+e\,x)^q \left(a+b\,x+c\,x^2\right)^p dx,\,x,\,x^2\right]$$

Program code:

```
Int[x_^m_.*(d_+e_.*x_^2)^q_.*(a_+b_.*x_^2+c_.*x_^4)^p_.,x_Symbol] :=
  1/2*Subst[Int[x^((m-1)/2)*(d+e*x)^q*(a+b*x+c*x^2)^p,x],x,x^2] /;
FreeQ[{a,b,c,d,e,p,q},x] && IntegerQ[(m-1)/2]
```

```
Int[x_^m_.*(d_+e_.*x_^2)^q_.*(a_+c_.*x_^4)^p_.,x_Symbol] :=
  1/2*Subst[Int[x^((m-1)/2)*(d+e*x)^q*(a+c*x^2)^p,x],x,x^2] /;
FreeQ[{a,c,d,e,p,q},x] && IntegerQ[(m+1)/2]
```

5. $\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p dx$ when $b^2-4\,a\,c\neq 0\,\wedge\,c\,d^2-b\,d\,e+a\,e^2==0$

1: $\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p dx$ when $b^2-4\,a\,c\neq 0\,\wedge\,c\,d^2-b\,d\,e+a\,e^2==0\,\wedge\,p\in\mathbb{Z}$

Derivation: Algebraic simplification

Basis: If $c\,d^2-b\,d\,e+a\,e^2==0$, **then** $a+b\,z+c\,z^2==(d+e\,z)\left(\frac{a}{d}+\frac{c\,z}{e}\right)$

Rule 1.2.2.4.5.1: If $b^2-4\,a\,c\neq 0\,\wedge\,c\,d^2-b\,d\,e+a\,e^2==0\,\wedge\,p\in\mathbb{Z}$, **then**

$$\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p dx\;\rightarrow\;\int (f\,x)^m \left(d+e\,x^2\right)^{q+p} \left(\frac{a}{d}+\frac{c\,x^2}{e}\right)^p dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_.*(a_+b_.*x_^2+c_.*x_^4)^p_.,x_Symbol] :=
  Int[(f*x)^m*(d+e*x^2)^(q+p)*(a/d+c/e*x^2)^p,x] /;
FreeQ[{a,b,c,d,e,f,m,q},x] && NeQ[b^2-4*a*c,0] && EqQ[c*d^2-b*d*e+a*e^2,0] && IntegerQ[p]
```

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_.*(a_+c_.*x_^4)^p_.,x_Symbol] :=
  Int[(f*x)^m*(d+e*x^2)^(q+p)*(a/d+c/e*x^2)^p,x] /;
FreeQ[{a,c,d,e,f,q,m,q},x] && EqQ[c*d^2+a*e^2,0] && IntegerQ[p]
```

2: $\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p dx$ when $b^2-4\,a\,c\neq 0\,\wedge\,c\,d^2-b\,d\,e+a\,e^2==0\,\wedge\,p\notin\mathbb{Z}$

Derivation: Piecewise constant extraction

- **Basis: If** $c\,d^2-b\,d\,e+a\,e^2==0$, **then** $\partial_x \frac{\left(a+b\,x^2+c\,x^4\right)^p}{\left(d+e\,x^2\right)^p \left(\frac{a}{d}+\frac{c\,x^2}{e}\right)^p}==0$
- **Basis: If** $c\,d^2-b\,d\,e+a\,e^2==0$, **then** $\frac{\left(a+b\,x^2+c\,x^4\right)^p}{\left(d+e\,x^2\right)^p \left(\frac{a}{d}+\frac{c\,x^2}{e}\right)^p}==\frac{\left(a+b\,x^2+c\,x^4\right)^{\text{FracPart}[p]}}{\left(d+e\,x^2\right)^{\text{FracPart}[p]} \left(\frac{a}{d}+\frac{c\,x^2}{e}\right)^{\text{FracPart}[p]}}$

Rule 1.2.2.4.5.2: If $b^2-4\,a\,c\neq 0\,\wedge\,c\,d^2-b\,d\,e+a\,e^2==0\,\wedge\,p\notin\mathbb{Z}$, **then**

$$\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p dx \,\to\, \frac{\left(a+b\,x^2+c\,x^4\right)^{\text{FracPart}[p]}}{\left(d+e\,x^2\right)^{\text{FracPart}[p]} \left(\frac{a}{d}+\frac{c\,x^2}{e}\right)^{\text{FracPart}[p]}} \int (f\,x)^m \left(d+e\,x^2\right)^{q+p} \left(\frac{a}{d}+\frac{c\,x^2}{e}\right)^p dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_*(a_+b_.*x_^2+c_.*x_^4)^p_,x_Symbol] :=
  (a+b*x^2+c*x^4)^FracPart[p]/((d+e*x^2)^FracPart[p]*(a/d+(c*x^2)/e)^FracPart[p])*
    Int[(f*x)^m*(d+e*x^2)^(q+p)*(a/d+c/e*x^2)^p,x] /;
FreeQ[{a,b,c,d,e,f,m,p,q},x] && NeQ[b^2-4*a*c,0] && EqQ[c*d^2-b*d*e+a*e^2,0] && Not[IntegerQ[p]]
```

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_*(a_+c_.*x_^4)^p_,x_Symbol] :=
  (a+c*x^4)^FracPart[p]/((d+e*x^2)^FracPart[p]*(a/d+(c*x^2)/e)^FracPart[p])*Int[(f*x)^m*(d+e*x^2)^(q+p)*(a/d+c/e*x^2)^p,x] /;
FreeQ[{a,c,d,e,f,m,p,q},x] && EqQ[c*d^2+a*e^2,0] && Not[IntegerQ[p]]
```

6. $\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p dx$ when $b^2-4\,a\,c\neq 0 \,\wedge\, p\in\mathbb{Z}^+$

   1. $\int x^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p dx$ when $b^2-4\,a\,c\neq 0 \,\bigwedge\, p\in\mathbb{Z}^+ \,\bigwedge\, \left(\frac{m}{2}\mid q\right)\in\mathbb{Z} \,\bigwedge\, q<-1$

      1: $\int x^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p dx$ when $b^2-4\,a\,c\neq 0 \,\bigwedge\, p\in\mathbb{Z}^+ \,\bigwedge\, \left(\frac{m}{2}\mid q\right)\in\mathbb{Z} \,\bigwedge\, q<-1 \,\bigwedge\, m>0$

Derivation: Algebraic expansion and binomial recurrence 2b

- **Note: If $p\in\mathbb{Z}^+ \bigwedge \left(\frac{m}{2}\mid q\right)\in\mathbb{Z} \bigwedge q<0$, then $\frac{(-d)^{m/2}}{e^{2p+m/2}}\sum_{k=0}^{2p}(-d)^k\, e^{2p-k}\, P_{2p}\left[x^2,\ k\right]$ is the coefficient of the $\left(d+e\,x^2\right)^q$ term of the partial fraction expansion of $x^m\, P_{2p}\left[x^2\right]\left(d+e\,x^2\right)^q$.**

- **Note: If $p\in\mathbb{Z}^+ \bigwedge \left(\frac{m}{2}\mid q\right)\in\mathbb{Z} \bigwedge q<-1 \bigwedge m>0$, then $2\,e^{2p+m/2}\,(q+1)\,x^m\left(a+b\,x^2+c\,x^4\right)^p-(-d)^{m/2-1}\left(c\,d^2-b\,d\,e+a\,e^2\right)^p\left(d+e\,(2\,q+3)\,x^2\right)$ will be divisible by $a+b\,x^2$.**

  Note: In the resulting integrand the degree of the polynomial in x^2 is at most $q-1$.

- **Rule 1.2.2.4.6.1.1: If $b^2-4\,a\,c\neq 0 \bigwedge p\in\mathbb{Z}^+ \bigwedge \left(\frac{m}{2}\mid q\right)\in\mathbb{Z} \bigwedge q<-1 \bigwedge m>0$, then**

$$\int x^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p dx \,\to$$

$$\frac{(-d)^{m/2}}{e^{2p+m/2}}\left(c\,d^2-b\,d\,e+a\,e^2\right)^p \int \left(d+e\,x^2\right)^q dx+\frac{1}{e^{2p+m/2}}\int \left(d+e\,x^2\right)^q \left(e^{2p+m/2}\,x^m\left(a+b\,x^2+c\,x^4\right)^p-(-d)^{m/2}\left(c\,d^2-b\,d\,e+a\,e^2\right)^p\right) dx \,\to$$

$$\frac{(-d)^{m/2-1}\left(c\,d^2-b\,d\,e+a\,e^2\right)^p x\left(d+e\,x^2\right)^{q+1}}{2\,e^{2p+m/2}\,(q+1)}+$$

$$\frac{1}{2\,e^{2\,p+m/2}\,(q+1)}\int (d+e\,x^2)^{q+1}\left(\frac{1}{d+e\,x^2}\left(2\,e^{2\,p+m/2}\,(q+1)\,x^m\,\left(a+b\,x^2+c\,x^4\right)^p-(-d)^{m/2-1}\left(c\,d^2-b\,d\,e+a\,e^2\right)^p\left(d+e\,(2\,q+3)\,x^2\right)\right)\right)dx$$

Program code:

```
Int[x_^m_.*(d_+e_.*x_^2)^q_*(a_+b_.*x_^2+c_.*x_^4)^p_.,x_Symbol] :=
  (-d)^(m/2-1)*(c*d^2-b*d*e+a*e^2)^p*x*(d+e*x^2)^(q+1)/(2*e^(2*p+m/2)*(q+1)) +
  1/(2*e^(2*p+m/2)*(q+1))*Int[(d+e*x^2)^(q+1)*
    ExpandToSum[Together[1/(d+e*x^2)*(2*e^(2*p+m/2)*(q+1)*x^m*(a+b*x^2+c*x^4)^p-
      (-d)^(m/2-1)*(c*d^2-b*d*e+a*e^2)^p*(d+e*(2*q+3)*x^2))],x],x] /;
FreeQ[{a,b,c,d,e},x] && NeQ[b^2-4*a*c,0] && IGtQ[p,0] && ILtQ[q,-1] && IGtQ[m/2,0]
```

```
Int[x_^m_.*(d_+e_.*x_^2)^q_*(a_+c_.*x_^4)^p_.,x_Symbol] :=
  (-d)^(m/2-1)*(c*d^2+a*e^2)^p*x*(d+e*x^2)^(q+1)/(2*e^(2*p+m/2)*(q+1)) +
  1/(2*e^(2*p+m/2)*(q+1))*Int[(d+e*x^2)^(q+1)*
    ExpandToSum[Together[1/(d+e*x^2)*(2*e^(2*p+m/2)*(q+1)*x^m*(a+c*x^4)^p-
      (-d)^(m/2-1)*(c*d^2+a*e^2)^p*(d+e*(2*q+3)*x^2))],x],x] /;
FreeQ[{a,c,d,e},x] && IGtQ[p,0] && ILtQ[q,-1] && IGtQ[m/2,0]
```

2: $\int x^m\,(d+e\,x^2)^q\,(a+b\,x^2+c\,x^4)^p\,dx$ when $b^2-4\,a\,c\neq 0\,\bigwedge\,p\in\mathbb{Z}^+\,\bigwedge\,\left(\frac{m}{2}\mid q\right)\in\mathbb{Z}\,\bigwedge\,q<-1\,\bigwedge\,m<0$

Derivation: Algebraic expansion and binomial recurrence 2b

Note: If $p\in\mathbb{Z}^+\wedge(m\mid q)\in\mathbb{Z}\wedge q<0$, then $\frac{(-d)^{m/2}}{e^{2\,p+m/2}}\sum_{k=0}^{2\,p}(-d)^k\,e^{2\,p-k}\,P_{2\,p}[x^2,\,k]$ is the coefficient of the $(d+e\,x^2)^q$ term of the partial fraction expansion of $x^m\,P_{2\,p}[x^2]\,(d+e\,x^2)^q$.

Note: If $p\in\mathbb{Z}^+\wedge(m\mid q)\in\mathbb{Z}\wedge q<-1\wedge m<0$, then $2\,(-d)^{-m/2+1}\,e^{2\,p}\,(q+1)\,\left(a+b\,x^2+c\,x^4\right)^p-e^{-m/2}\left(c\,d^2-b\,d\,e+a\,e^2\right)^p x^{-m}\left(d+e\,(2\,q+3)\,x^2\right)$ will be divisible by $a+b\,x^2$.

Note: In the resulting integrand the degree of the polynomial in x^2 is at most $q-1$.

Rule 1.2.2.4.6.1.2: If $b^2-4\,a\,c\neq 0\,\bigwedge\,p\in\mathbb{Z}^+\,\bigwedge\,\left(\frac{m}{2}\mid q\right)\in\mathbb{Z}\,\bigwedge\,q<-1\,\bigwedge\,m<0$, then

$$\int x^m\,(d+e\,x^2)^q\,(a+b\,x^2+c\,x^4)^p\,dx\,\longrightarrow$$

$$\frac{(-d)^{m/2}}{e^{2\,p+m/2}}\left(c\,d^2-b\,d\,e+a\,e^2\right)^p\int(d+e\,x^2)^q\,dx+$$
$$\frac{(-d)^{m/2}}{e^{2\,p}}\int x^m\,(d+e\,x^2)^q\left((-d)^{-m/2}\,e^{2\,p}\,(a+b\,x^2+c\,x^4)^p-e^{-m/2}\left(c\,d^2-b\,d\,e+a\,e^2\right)^p x^{-m}\right)dx\,\longrightarrow$$

$$\frac{(-d)^{m/2-1}\left(c\,d^2-b\,d\,e+a\,e^2\right)^p x\left(d+e\,x^2\right)^{q+1}}{2\,e^{2\,p+m/2}\,(q+1)}+$$
$$\frac{(-d)^{m/2-1}}{2\,e^{2\,p}\,(q+1)}\int x^m\left(d+e\,x^2\right)^{q+1}\left(\frac{1}{d+e\,x^2}\left(2\,(-d)^{-m/2+1}\,e^{2\,p}\,(q+1)\,\left(a+b\,x^2+c\,x^4\right)^p-e^{-m/2}\left(c\,d^2-b\,d\,e+a\,e^2\right)^p x^{-m}\left(d+e\,(2\,q+3)\,x^2\right)\right)\right)dx$$

Program code:

```
Int[x_^m_*(d_+e_.*x_^2)^q_*(a_+b_.*x_^2+c_.*x_^4)^p_.,x_Symbol] :=
  (-d)^(m/2-1)*(c*d^2-b*d*e+a*e^2)^p*x*(d+e*x^2)^(q+1)/(2*e^(2*p+m/2)*(q+1)) +
  (-d)^(m/2-1)/(2*e^(2*p)*(q+1))*Int[x^m*(d+e*x^2)^(q+1)*
    ExpandToSum[Together[1/(d+e*x^2)*(2*(-d)^(-m/2+1)*e^(2*p)*(q+1)*(a+b*x^2+c*x^4)^p -
      (e^(-m/2)*(c*d^2-b*d*e+a*e^2)^p*x^(-m))*(d+e*(2*q+3)*x^2))],x],x] /;
FreeQ[{a,b,c,d,e},x] && NeQ[b^2-4*a*c,0] && IGtQ[p,0] && ILtQ[q,-1] && ILtQ[m/2,0]
```

```
Int[x_^m_*(d_+e_.*x_^2)^q_*(a_+c_.*x_^4)^p_.,x_Symbol] :=
  (-d)^(m/2-1)*(c*d^2+a*e^2)^p*x*(d+e*x^2)^(q+1)/(2*e^(2*p+m/2)*(q+1)) +
  (-d)^(m/2-1)/(2*e^(2*p)*(q+1))*Int[x^m*(d+e*x^2)^(q+1)*
    ExpandToSum[Together[1/(d+e*x^2)*(2*(-d)^(-m/2+1)*e^(2*p)*(q+1)*(a+c*x^4)^p -
      (e^(-m/2)*(c*d^2+a*e^2)^p*x^(-m))*(d+e*(2*q+3)*x^2))],x],x] /;
FreeQ[{a,c,d,e},x] && IGtQ[p,0] && ILtQ[q,-1] && ILtQ[m/2,0]
```

2: $\int (f\,x)^m\left(d+e\,x^2\right)^q\left(a+b\,x^2+c\,x^4\right)^p dx$ when $b^2-4\,a\,c\neq 0\,\wedge\,p\in\mathbb{Z}^+\wedge\,q+2\in\mathbb{Z}^+$

Derivation: Algebraic expansion

Rule 1.2.2.4.6.2: If $b^2-4\,a\,c\neq 0\,\wedge\,p\in\mathbb{Z}^+\wedge\,q+2\in\mathbb{Z}^+$**, then**

$$\int (f\,x)^m\left(d+e\,x^2\right)^q\left(a+b\,x^2+c\,x^4\right)^p dx\;\longrightarrow\;\int \text{ExpandIntegrand}\left[(f\,x)^m\left(d+e\,x^2\right)^q\left(a+b\,x^2+c\,x^4\right)^p,\,x\right]dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_.*(a_+b_.*x_^2+c_.*x_^4)^p_.,x_Symbol] :=
  Int[ExpandIntegrand[(f*x)^m*(d+e*x^2)^q*(a+b*x^2+c*x^4)^p,x],x] /;
FreeQ[{a,b,c,d,e,f,m,q},x] && NeQ[b^2-4*a*c,0] && IGtQ[p,0] && IGtQ[q,-2]
```

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_.*(a_+c_.*x_^4)^p_.,x_Symbol] :=
  Int[ExpandIntegrand[(f*x)^m*(d+e*x^2)^q*(a+c*x^4)^p,x],x] /;
FreeQ[{a,c,d,e,f,m,q},x] && IGtQ[p,0] && IGtQ[q,-2]
```

3: $\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p dx$ when $b^2-4\,a\,c\neq 0\ \land\ p\in\mathbb{Z}^+\ \land\ q<-1\ \land\ m>0$

Derivation: Algebraic expansion and quadratic recurrence 2a

Rule 1.2.2.4.6.3: If $b^2-4\,a\,c\neq 0\ \land\ p\in\mathbb{Z}^+\ \land\ q<-1\ \land\ m>0$,
let $Q[x]\to \text{PolynomialQuotient}\left[\left(a+b\,x^2+c\,x^4\right)^p,\ d+e\,x^2,\ x\right]$ and $R\to \text{PolynomialRemainder}\left[\left(a+b\,x^2+c\,x^4\right)^p,\ d+e\,x^2,\ x\right]$, then

$$\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p dx\ \longrightarrow$$

$$R\int (f\,x)^m \left(d+e\,x^2\right)^q dx+\int (f\,x)^{m-1}\,(f\,x)\,Q[x]\left(d+e\,x^2\right)^{q+1} dx\ \longrightarrow$$

$$-\frac{R\,(f\,x)^{m+1}\left(d+e\,x^2\right)^{q+1}}{2\,d\,f\,(q+1)}+\frac{f}{2\,d\,(q+1)}\int (f\,x)^{m-1}\left(d+e\,x^2\right)^{q+1}\left(2\,d\,(q+1)\,x\,Q[x]+R\,(m+2\,q+3)\,x\right)dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_*(a_+b_.*x_^2+c_.*x_^4)^p_.,x_Symbol] :=
  With[{Qx=PolynomialQuotient[(a+b*x^2+c*x^4)^p,d+e*x^2,x],
        R=Coeff[PolynomialRemainder[(a+b*x^2+c*x^4)^p,d+e*x^2,x],x,0]},
  -R*(f*x)^(m+1)*(d+e*x^2)^(q+1)/(2*d*f*(q+1)) +
  f/(2*d*(q+1))*Int[(f*x)^(m-1)*(d+e*x^2)^(q+1)*ExpandToSum[2*d*(q+1)*x*Qx+R*(m+2*q+3)*x,x],x]] /;
FreeQ[{a,b,c,d,e,f},x] && NeQ[b^2-4*a*c,0] && IGtQ[p,0] && LtQ[q,-1] && GtQ[m,0]
```

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_*(a_+c_.*x_^4)^p_.,x_Symbol] :=
  With[{Qx=PolynomialQuotient[(a+c*x^4)^p,d+e*x^2,x],
        R=Coeff[PolynomialRemainder[(a+c*x^4)^p,d+e*x^2,x],x,0]},
  -R*(f*x)^(m+1)*(d+e*x^2)^(q+1)/(2*d*f*(q+1)) +
  f/(2*d*(q+1))*Int[(f*x)^(m-1)*(d+e*x^2)^(q+1)*ExpandToSum[2*d*(q+1)*x*Qx+R*(m+2*q+3)*x,x],x]] /;
FreeQ[{a,c,d,e,f},x] && IGtQ[p,0] && LtQ[q,-1] && GtQ[m,0]
```

4: $\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p dx$ when $b^2-4\,a\,c\neq 0\ \land\ p\in\mathbb{Z}^+\ \land\ m<-1$

Derivation: Algebraic expansion and quadratic recurrence 3b

Rule 1.2.2.4.6.4: If $b^2-4\,a\,c\neq 0\ \land\ p\in\mathbb{Z}^+\ \land\ m<-1$,
let $Q[x]\to \text{PolynomialQuotient}\left[\left(a+b\,x^2+c\,x^4\right)^p,\ f\,x,\ x\right]$ and $R\to \text{PolynomialRemainder}\left[\left(a+b\,x^2+c\,x^4\right)^p,\ f\,x,\ x\right]$, then

$$\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p dx \longrightarrow$$

$$R\int (f\,x)^m \left(d+e\,x^2\right)^q dx+\int (f\,x)^{m+1}\,Q[x]\left(d+e\,x^2\right)^q dx \longrightarrow$$

$$\frac{R\,(f\,x)^{m+1}\left(d+e\,x^2\right)^{q+1}}{d\,f\,(m+1)}+\frac{1}{d\,f^2\,(m+1)}\int (f\,x)^{m+2}\left(d+e\,x^2\right)^q\left(\frac{d\,f\,(m+1)\,Q[x]}{x}-e\,R\,(m+2\,q+3)\right)dx$$

Program code:

```
Int[(f_.*x_)^m_*(d_+e_.*x_^2)^q_.*(a_+b_.*x_^2+c_.*x_^4)^p_.,x_Symbol] :=
  With[{Qx=PolynomialQuotient[(a+b*x^2+c*x^4)^p,f*x,x], R=PolynomialRemainder[(a+b*x^2+c*x^4)^p,f*x,x]},
  R*(f*x)^(m+1)*(d+e*x^2)^(q+1)/(d*f*(m+1)) +
  1/(d*f^2*(m+1))*Int[(f*x)^(m+2)*(d+e*x^2)^q*ExpandToSum[d*f*(m+1)*Qx/x-e*R*(m+2*q+3),x],x]] /;
FreeQ[{a,b,c,d,e,f,q},x] && NeQ[b^2-4*a*c,0] && IGtQ[p,0] && LtQ[m,-1]
```

```
Int[(f_.*x_)^m_*(d_+e_.*x_^2)^q_.*(a_+c_.*x_^4)^p_.,x_Symbol] :=
  With[{Qx=PolynomialQuotient[(a+c*x^4)^p,f*x,x], R=PolynomialRemainder[(a+c*x^4)^p,f*x,x]},
  R*(f*x)^(m+1)*(d+e*x^2)^(q+1)/(d*f*(m+1)) +
  1/(d*f^2*(m+1))*Int[(f*x)^(m+2)*(d+e*x^2)^q*ExpandToSum[d*f*(m+1)*Qx/x-e*R*(m+2*q+3),x],x]] /;
FreeQ[{a,c,d,e,f,q},x] && IGtQ[p,0] && LtQ[m,-1]
```

5: $\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p dx$ when $b^2-4\,a\,c\neq 0\,\wedge\,p\in\mathbb{Z}^+\wedge\,q\notin\mathbb{Z}\,\wedge\,m+4\,p+2\,q+1\neq 0$

Reference: G&R 2.104

Derivation: Algebraic expansion and binomial recurrence 3a

Rule 1.2.2.4.6.5: If $b^2-4\,a\,c\neq 0\,\wedge\,p\in\mathbb{Z}^+\wedge\,q\notin\mathbb{Z}\,\wedge\,m+4\,p+2\,q+1\neq 0$**, then**

$$\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p dx \longrightarrow$$

$$\frac{c^p}{f^{4\,p}}\int (f\,x)^{m+4\,p} \left(d+e\,x^2\right)^q dx+\int (f\,x)^m \left(d+e\,x^2\right)^q \left(\left(a+b\,x^2+c\,x^4\right)^p-x^{4\,p}\right) dx \longrightarrow$$

$$\frac{c^p\,(f\,x)^{m+4\,p-1}\left(d+e\,x^2\right)^{q+1}}{e\,f^{4\,p-1}\,(m+4\,p+2\,q+1)}+\frac{1}{e\,(m+4\,p+2\,q+1)}\int (f\,x)^m \left(d+e\,x^2\right)^q \left(e\,(m+4\,p+2\,q+1)\left(\left(a+b\,x^2+c\,x^4\right)^p-c^p\,x^{4\,p}\right)-d\,c^p\,(m+4\,p-1)\,x^{4\,p-2}\right) dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_.*(a_+b_.*x_^2+c_.*x_^4)^p_.,x_Symbol] :=
  c^p*(f*x)^(m+4*p-1)*(d+e*x^2)^(q+1)/(e*f^(4*p-1)*(m+4*p+2*q+1)) +
  1/(e*(m+4*p+2*q+1))*Int[(f*x)^m*(d+e*x^2)^q*
    ExpandToSum[e*(m+4*p+2*q+1)*((a+b*x^2+c*x^4)^p-c^p*x^(4*p))-d*c^p*(m+4*p-1)*x^(4*p-2),x],x] /;
FreeQ[{a,b,c,d,e,f,m,q},x] && NeQ[b^2-4*a*c,0] && IGtQ[p,0] && Not[IntegerQ[q]] && NeQ[m+4*p+2*q+1,0]
```

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_.*(a_+c_.*x_^4)^p_.,x_Symbol] :=
  c^p*(f*x)^(m+4*p-1)*(d+e*x^2)^(q+1)/(e*f^(4*p-1)*(m+4*p+2*q+1)) +
  1/(e*(m+4*p+2*q+1))*Int[(f*x)^m*(d+e*x^2)^q*
    ExpandToSum[e*(m+4*p+2*q+1)*((a+c*x^4)^p-c^p*x^(4*p))-d*c^p*(m+4*p-1)*x^(4*p-2),x],x] /;
FreeQ[{a,c,d,e,f,m,q},x] && IGtQ[p,0] && Not[IntegerQ[q]] && NeQ[m+4*p+2*q+1,0]
```

7: $\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p dx$ when $b^2-4\,a\,c\neq 0\,\wedge\,m\in\mathbb{F}$

Derivation: Integration by substitution

Basis: If $k\in\mathbb{Z}^+$**, then** $(f\,x)^m\,F[x] = \frac{k}{f}\,\text{Subst}\left[x^{k\,(m+1)-1}\,F\left[\frac{x^k}{f}\right],\,x,\,(f\,x)^{1/k}\right]\partial_x\,(f\,x)^{1/k}$

Rule 1.2.2.4.7: If $b^2-4\,a\,c\neq 0\,\wedge\,m\in\mathbb{F}$**, let** $k=\text{Denominator}[m]$**, then**

$$\int (f x)^m \left(d+e x^2\right)^q \left(a+b x^2+c x^4\right)^p dx \longrightarrow \frac{k}{f} \operatorname{Subst}\left[\int x^{k (m+1)-1} \left(d+\frac{e x^{2k}}{f^2}\right)^q \left(a+\frac{b x^{2k}}{f^2}+\frac{c x^{4k}}{f^4}\right)^p dx, x, (f x)^{1/k}\right]$$

Program code:

```
Int[(f_.*x_)^m_*(d_+e_.*x_^2)^q_.*(a_+b_.*x_^2+c_.*x_^4)^p_,x_Symbol] :=
  With[{k=Denominator[m]},
  k/f*Subst[Int[x^(k*(m+1)-1)*(d+e*x^(2*k)/f^2)^q*(a+b*x^(2*k)/f^k+c*x^(4*k)/f^4)^p,x],x,(f*x)^(1/k)]] /;
FreeQ[{a,b,c,d,e,f,p,q},x] && NeQ[b^2-4*a*c,0] && FractionQ[m] && IntegerQ[p]
```

```
Int[(f_.*x_)^m_*(d_+e_.*x_^2)^q_.*(a_+c_.*x_^4)^p_,x_Symbol] :=
  With[{k=Denominator[m]},
  k/f*Subst[Int[x^(k*(m+1)-1)*(d+e*x^(2*k)/f)^q*(a+c*x^(4*k)/f)^p,x],x,(f*x)^(1/k)]] /;
FreeQ[{a,c,d,e,f,p,q},x] && FractionQ[m] && IntegerQ[p]
```

8. $\int (f x)^m \left(d+e x^2\right) \left(a+b x^2+c x^4\right)^p dx$ when $b^2-4 a c \neq 0$

1. $\int (f x)^m \left(d+e x^2\right) \left(a+b x^2+c x^4\right)^p dx$ when $b^2-4 a c \neq 0 \land p>0$

1: $\int (f x)^m \left(d+e x^2\right) \left(a+b x^2+c x^4\right)^p dx$ when $b^2-4 a c \neq 0 \land p>0 \land m<-1 \land m+2 (2 p+1)+1 \neq 0$

Derivation: Trinomial recurrence 1a

Rule 1.2.2.4.8.1.1: If $b^2-4 a c \neq 0 \land p>0 \land m<-1 \land m+2 (2 p+1)+1 \neq 0$, then

$$\int (f x)^m \left(d+e x^2\right) \left(a+b x^2+c x^4\right)^p dx \longrightarrow$$

$$\frac{(f x)^{m+1} \left(a+b x^2+c x^4\right)^p \left(d (4 p+m+3)+e (m+1) x^2\right)}{f (m+1) (m+4 p+3)}+$$
$$\frac{2 p}{f^2 (m+1) (m+4 p+3)} \int (f x)^{m+2} \left(a+b x^2+c x^4\right)^{p-1} \left(2 a e (m+1)-b d (m+4 p+3)+(b e (m+1)-2 c d (m+4 p+3)) x^2\right) dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)*(a_+b_.*x_^2+c_.*x_^4)^p_.,x_Symbol] :=
  (f*x)^(m+1)*(a+b*x^2+c*x^4)^p*(d*(m+4*p+3)+e*(m+1)*x^2)/(f*(m+1)*(m+4*p+3)) +
  2*p/(f^2*(m+1)*(m+4*p+3))*Int[(f*x)^(m+2)*(a+b*x^2+c*x^4)^(p-1)*
    Simp[2*a*e*(m+1)-b*d*(m+4*p+3)+(b*e*(m+1)-2*c*d*(m+4*p+3))*x^2,x],x] /;
FreeQ[{a,b,c,d,e,f},x] && NeQ[b^2-4*a*c,0] && GtQ[p,0] && LtQ[m,-1] && m+4*p+3≠0 && IntegerQ[2*p] && (IntegerQ[p] || IntegerQ[m]
```

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)*(a_+c_.*x_^4)^p_.,x_Symbol] :=
  (f*x)^(m+1)*(a+c*x^4)^p*(d*(m+4*p+3)+e*(m+1)*x^2)/(f*(m+1)*(m+4*p+3)) +
  4*p/(f^2*(m+1)*(m+4*p+3))*Int[(f*x)^(m+2)*(a+c*x^4)^(p-1)*(a*e*(m+1)-c*d*(m+4*p+3)*x^2),x] /;
FreeQ[{a,c,d,e,f},x] && GtQ[p,0] && LtQ[m,-1] && m+4*p+3≠0 && IntegerQ[2*p] && (IntegerQ[p] || IntegerQ[m])
```

2: $\int (f x)^m \left(d+e x^2\right) \left(a+b x^2+c x^4\right)^p dx$ when $b^2-4 a c \neq 0 \land p>0 \land m+4 p+1 \neq 0 \land m+4 p+3 \neq 0$

Derivation: Trinomial recurrence 1b

Rule 1.2.2.4.8.1.2: If $b^2-4 a c \neq 0 \land p>0 \land m+4 p+1 \neq 0 \land m+4 p+3 \neq 0$, **then**

$$\int (f x)^m \left(d+e x^2\right) \left(a+b x^2+c x^4\right)^p dx \longrightarrow$$

$$\frac{(f x)^{m+1} \left(a+b x^2+c x^4\right)^p \left(2 b e p+c d (m+4 p+3)+c e (4 p+m+1) x^2\right)}{c f (m+4 p+1) (m+4 p+3)}+$$

$$\frac{2 p}{c (m+4 p+1) (m+4 p+3)} \int (f x)^m \left(a+b x^2+c x^4\right)^{p-1} \cdot$$

$$\left(2 a c d (m+4 p+3)-a b e (m+1)+\left(2 a c e (m+4 p+1)+b c d (m+4 p+3)-b^2 e (m+2 p+1)\right) x^2\right) dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)*(a_+b_.*x_^2+c_.*x_^4)^p_.,x_Symbol] :=
  (f*x)^(m+1)*(a+b*x^2+c*x^4)^p*(b*e*2*p+c*d*(m+4*p+3)+c*e*(4*p+m+1)*x^2)/
    (c*f*(4*p+m+1)*(m+4*p+3)) +
  2*p/(c*(4*p+m+1)*(m+4*p+3))*Int[(f*x)^m*(a+b*x^2+c*x^4)^(p-1)*
    Simp[2*a*c*d*(m+4*p+3)-a*b*e*(m+1)+(2*a*c*e*(4*p+m+1)+b*c*d*(m+4*p+3)-b^2*e*(m+2*p+1))*x^2,x],x] /;
FreeQ[{a,b,c,d,e,f,m},x] && NeQ[b^2-4*a*c,0] && GtQ[p,0] && NeQ[4*p+m+1,0] && NeQ[m+4*p+3,0] && IntegerQ[2*p] && (IntegerQ[p] ||
```

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)*(a_+c_.*x_^4)^p_.,x_Symbol] :=
  (f*x)^(m+1)*(a+c*x^4)^p*(c*d*(m+4*p+3)+c*e*(4*p+m+1)*x^2)/(c*f*(4*p+m+1)*(m+4*p+3)) +
  4*a*p/((4*p+m+1)*(m+4*p+3))*Int[(f*x)^m*(a+c*x^4)^(p-1)*Simp[d*(m+4*p+3)+e*(4*p+m+1)*x^2,x],x] /;
FreeQ[{a,c,d,e,f,m},x] && GtQ[p,0] && NeQ[4*p+m+1,0] && NeQ[m+4*p+3,0] && IntegerQ[2*p] && (IntegerQ[p] || IntegerQ[m])
```

2. $\int (f\,x)^m \left(d+e\,x^2\right) \left(a+b\,x^2+c\,x^4\right)^p dx$ when $b^2-4\,a\,c\neq 0\,\land\,p<-1$

1: $\int (f\,x)^m \left(d+e\,x^2\right) \left(a+b\,x^2+c\,x^4\right)^p dx$ when $b^2-4\,a\,c\neq 0\,\land\,p<-1\,\land\,m>1$

Derivation: Trinomial recurrence 2a

Rule 1.2.2.4.8.2.1: If $b^2-4\,a\,c\neq 0\,\land\,p<-1\,\land\,m>1$, then

$$\int (f\,x)^m \left(d+e\,x^2\right) \left(a+b\,x^2+c\,x^4\right)^p dx \longrightarrow$$

$$\frac{f\,(f\,x)^{m-1} \left(a+b\,x^2+c\,x^4\right)^{p+1} \left(b\,d-2\,a\,e-(b\,e-2\,c\,d)\,x^2\right)}{2\,(p+1)\left(b^2-4\,a\,c\right)}-$$

$$\frac{f^2}{2\,(p+1)\left(b^2-4\,a\,c\right)}\int (f\,x)^{m-2} \left(a+b\,x^2+c\,x^4\right)^{p+1} \left((m-1)\,(b\,d-2\,a\,e)-(4\,p+m+5)\,(b\,e-2\,c\,d)\,x^2\right) dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)*(a_+b_.*x_^2+c_.*x_^4)^p_.,x_Symbol] :=
  f*(f*x)^(m-1)*(a+b*x^2+c*x^4)^(p+1)*(b*d-2*a*e-(b*e-2*c*d)*x^2)/(2*(p+1)*(b^2-4*a*c)) -
  f^2/(2*(p+1)*(b^2-4*a*c))*Int[(f*x)^(m-2)*(a+b*x^2+c*x^4)^(p+1)*
    Simp[(m-1)*(b*d-2*a*e)-(4*p+4+m+1)*(b*e-2*c*d)*x^2,x],x] /;
FreeQ[{a,b,c,d,e,f},x] && NeQ[b^2-4*a*c,0] && LtQ[p,-1] && GtQ[m,1] && IntegerQ[2*p] && (IntegerQ[p] || IntegerQ[m])
```

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)*(a_+c_.*x_^4)^p_.,x_Symbol] :=
  f*(f*x)^(m-1)*(a+c*x^4)^(p+1)*(a*e-c*d*x^2)/(4*a*c*(p+1)) -
  f^2/(4*a*c*(p+1))*Int[(f*x)^(m-2)*(a+c*x^4)^(p+1)*(a*e*(m-1)-c*d*(4*p+4+m+1)*x^2),x] /;
FreeQ[{a,c,d,e,f},x] && LtQ[p,-1] && GtQ[m,1] && IntegerQ[2*p] && (IntegerQ[p] || IntegerQ[m])
```

2: $\int (f\,x)^m \left(d+e\,x^2\right) \left(a+b\,x^2+c\,x^4\right)^p dx$ when $b^2-4\,a\,c\neq 0\,\land\,p<-1$

Derivation: Trinomial recurrence 2b

Rule 1.2.2.4.8.2.2: If $b^2-4\,a\,c\neq 0\,\land\,p<-1$, then

$$\int (f\,x)^m \left(d+e\,x^2\right) \left(a+b\,x^2+c\,x^4\right)^p dx \longrightarrow$$

$$-\frac{(f x)^{m+1} \left(a+b x^2+c x^4\right)^{p+1} \left(d \left(b^2-2 a c\right)-a b e+(b d-2 a e) c x^2\right)}{2 a f (p+1) \left(b^2-4 a c\right)}+\frac{1}{2 a (p+1) \left(b^2-4 a c\right)} \int (f x)^m \left(a+b x^2+c x^4\right)^{p+1} \cdot$$
$$\left(d \left(b^2 (m+2 p+3)-2 a c (m+4 (p+1)+1)\right)-a b e (m+1)+c (m+2 (2 p+3)+1) (b d-2 a e) x^2\right) dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)*(a_+b_.*x_^2+c_.*x_^4)^p_,x_Symbol] :=
  -(f*x)^(m+1)*(a+b*x^2+c*x^4)^(p+1)*(d*(b^2-2*a*c)-a*b*e+(b*d-2*a*e)*c*x^2)/(2*a*f*(p+1)*(b^2-4*a*c)) +
  1/(2*a*(p+1)*(b^2-4*a*c))*Int[(f*x)^m*(a+b*x^2+c*x^4)^(p+1)*
    Simp[d*(b^2*(m+2*(p+1)+1)-2*a*c*(m+4*(p+1)+1))-a*b*e*(m+1)+c*(m+2*(2*p+3)+1)*(b*d-2*a*e)*x^2,x],x] /;
FreeQ[{a,b,c,d,e,f,m},x] && NeQ[b^2-4*a*c,0] && LtQ[p,-1] && IntegerQ[2*p] && (IntegerQ[p] || IntegerQ[m])
```

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)*(a_+c_.*x_^4)^p_,x_Symbol] :=
  -(f*x)^(m+1)*(a+c*x^4)^(p+1)*(d+e*x^2)/(4*a*f*(p+1)) +
  1/(4*a*(p+1))*Int[(f*x)^m*(a+c*x^4)^(p+1)*Simp[d*(m+4*(p+1)+1)+e*(m+2*(2*p+3)+1)*x^2,x],x] /;
FreeQ[{a,c,d,e,f,m},x] && LtQ[p,-1] && IntegerQ[2*p] && (IntegerQ[p] || IntegerQ[m])
```

3: $\int (f x)^m \left(d+e x^2\right) \left(a+b x^2+c x^4\right)^p dx$ when $b^2-4 a c \neq 0 \land m>1 \land m+4 p+3 \neq 0$

Derivation: Trinomial recurrence 3a

Rule 1.2.2.4.8.3: If $b^2-4 a c \neq 0 \land m>1 \land m+4 p+3 \neq 0$, then

$$\int (f x)^m \left(d+e x^2\right) \left(a+b x^2+c x^4\right)^p dx \longrightarrow$$
$$\frac{e f (f x)^{m-1} \left(a+b x^2+c x^4\right)^{p+1}}{c (m+4 p+3)}-$$
$$\frac{f^2}{c (m+4 p+3)} \int (f x)^{m-2} \left(a+b x^2+c x^4\right)^p \left(a e (m-1)+(b e (m+2 p+1)-c d (m+4 p+3)) x^2\right) dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)*(a_+b_.*x_^2+c_.*x_^4)^p_,x_Symbol] :=
  e*f*(f*x)^(m-1)*(a+b*x^2+c*x^4)^(p+1)/(c*(m+4*p+3)) -
  f^2/(c*(m+4*p+3))*Int[(f*x)^(m-2)*(a+b*x^2+c*x^4)^p*Simp[a*e*(m-1)+(b*e*(m+2*p+1)-c*d*(m+4*p+3))*x^2,x],x] /;
FreeQ[{a,b,c,d,e,f,p},x] && NeQ[b^2-4*a*c,0] && GtQ[m,1] && NeQ[m+4*p+3,0] && IntegerQ[2*p] && (IntegerQ[p] || IntegerQ[m])
```

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)*(a_+c_.*x_^4)^p_,x_Symbol] :=
  e*f*(f*x)^(m-1)*(a+c*x^4)^(p+1)/(c*(m+4*p+3)) -
  f^2/(c*(m+4*p+3))*Int[(f*x)^(m-2)*(a+c*x^4)^p*(a*e*(m-1)-c*d*(m+4*p+3)*x^2),x] /;
FreeQ[{a,c,d,e,f,p},x] && GtQ[m,1] && NeQ[m+4*p+3,0] && IntegerQ[2*p] && (IntegerQ[p] || IntegerQ[m])
```

4: $\int (f\,x)^m \left(d+e\,x^2\right) \left(a+b\,x^2+c\,x^4\right)^p dx$ when $b^2-4\,a\,c\neq 0\,\wedge\,m<-1$

Derivation: Trinomial recurrence 3b

Rule 1.2.2.4.4.8.4: If $b^2-4\,a\,c\neq 0\,\wedge\,m<-1$, then

$$\int (f\,x)^m \left(d+e\,x^2\right) \left(a+b\,x^2+c\,x^4\right)^p dx \longrightarrow$$

$$\frac{d\,(f\,x)^{m+1} \left(a+b\,x^2+c\,x^4\right)^{p+1}}{a\,f\,(m+1)}+$$

$$\frac{1}{a\,f^2\,(m+1)} \int (f\,x)^{m+2} \left(a+b\,x^2+c\,x^4\right)^p \left(a\,e\,(m+1)-b\,d\,(m+2\,p+3)-c\,d\,(m+4\,p+5)\,x^2\right) dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)*(a_+b_.*x_^2+c_.*x_^4)^p_,x_Symbol] :=
  d*(f*x)^(m+1)*(a+b*x^2+c*x^4)^(p+1)/(a*f*(m+1)) +
  1/(a*f^2*(m+1))*Int[(f*x)^(m+2)*(a+b*x^2+c*x^4)^p*Simp[a*e*(m+1)-b*d*(m+2*p+3)-c*d*(m+4*p+5)*x^2,x],x] /;
FreeQ[{a,b,c,d,e,f,p},x] && NeQ[b^2-4*a*c,0] && LtQ[m,-1] && IntegerQ[2*p] && (IntegerQ[p] || IntegerQ[m])
```

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)*(a_+c_.*x_^4)^p_,x_Symbol] :=
  d*(f*x)^(m+1)*(a+c*x^4)^(p+1)/(a*f*(m+1)) +
  1/(a*f^2*(m+1))*Int[(f*x)^(m+2)*(a+c*x^4)^p*(a*e*(m+1)-c*d*(m+4*p+5)*x^2),x] /;
FreeQ[{a,c,d,e,f,p},x] && LtQ[m,-1] && IntegerQ[2*p] && (IntegerQ[p] || IntegerQ[m])
```

5. $\int \frac{(f\,x)^m\,(d+e\,x^2)}{a+b\,x^2+c\,x^4}\,dx$ when $b^2-4\,a\,c\neq 0$

1: $\int \frac{(f\,x)^m\,(d+e\,x^2)}{a+b\,x^2+c\,x^4}\,dx$ when $b^2-4\,a\,c\neq 0\,\bigwedge\,c\,d^2-a\,e^2==0\,\bigwedge\,\frac{d}{e}>0\,\bigwedge\,\frac{c}{e}\,(2\,c\,d-b\,e)>0$

Derivation: Algebraic expansion

- **Basis: If** $c\,d^2-a\,e^2=0$, **let** $r=\sqrt{\frac{c}{e}\,(2\,c\,d-b\,e)}$, **then** $\frac{d+e\,x^2}{a+b\,x^2+c\,x^4}==\frac{e}{2\left(\frac{c\,d}{e}+r\,x+c\,x^2\right)}+\frac{e}{2\left(\frac{c\,d}{e}-r\,x+c\,x^2\right)}$

- **Rule 1.2.2.4.8.5.1: If** $b^2-4\,a\,c\neq 0\,\bigwedge\,c\,d^2-a\,e^2==0\,\bigwedge\,\frac{d}{e}>0\,\bigwedge\,\frac{c}{e}\,(2\,c\,d-b\,e)>0$, **let** $r=\sqrt{\frac{c}{e}\,(2\,c\,d-b\,e)}$, **then**

$$\int \frac{(f\,x)^m\,(d+e\,x^2)}{a+b\,x^2+c\,x^4}\,dx\;\rightarrow\;\frac{e}{2}\int \frac{(f\,x)^m}{\frac{c\,d}{e}-r\,x+c\,x^2}\,dx+\frac{e}{2}\int \frac{(f\,x)^m}{\frac{c\,d}{e}+r\,x+c\,x^2}\,dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)/(a_+b_.*x_^2+c_.*x_^4), x_Symbol] :=
  With[{r=Rt[c/e*(2*c*d-b*e),2]},
  e/2*Int[(f*x)^m/(c*d/e-r*x+c*x^2),x] +
  e/2*Int[(f*x)^m/(c*d/e+r*x+c*x^2),x]] /;
FreeQ[{a,b,c,d,e,f,m},x] && NeQ[b^2-4*a*c,0] && EqQ[c*d^2-a*e^2,0] && GtQ[d/e,0] && PosQ[c/e*(2*c*d-b*e)]
```

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)/(a_+c_.*x_^4), x_Symbol] :=
  With[{r=Rt[2*c^2*d/e,2]},
  e/2*Int[(f*x)^m/(c*d/e-r*x+c*x^2),x] +
  e/2*Int[(f*x)^m/(c*d/e+r*x+c*x^2),x]] /;
FreeQ[{a,c,d,e,f,m},x] && EqQ[c*d^2-a*e^2,0] && GtQ[d/e,0]
```

2: $\int \frac{(f\,x)^m\,(d+e\,x^2)}{a+b\,x^2+c\,x^4}\,dx$ when $b^2-4\,a\,c\neq 0$

Derivation: Algebraic expansion

- **Basis: Let** $q\rightarrow\sqrt{b^2-4\,a\,c}$, **then** $\frac{d+e\,z}{a+b\,z+c\,z^2}==\left(\frac{e}{2}+\frac{2\,c\,d-b\,e}{2\,q}\right)\frac{1}{\frac{b}{2}-\frac{q}{2}+c\,z}+\left(\frac{e}{2}-\frac{2\,c\,d-b\,e}{2\,q}\right)\frac{1}{\frac{b}{2}+\frac{q}{2}+c\,z}$

- **Rule 1.2.2.4.8.5.2: If** $b^2-4\,a\,c\neq 0$, **let** $q\rightarrow\sqrt{b^2-4\,a\,c}$, **then**

$$\int \frac{(f\,x)^m \left(d+e\,x^2\right)}{a+b\,x^2+c\,x^4}\,dx \longrightarrow \left(\frac{e}{2}+\frac{2\,c\,d-b\,e}{2\,q}\right)\int \frac{(f\,x)^m}{\frac{b}{2}-\frac{q}{2}+c\,x^2}\,dx+\left(\frac{e}{2}-\frac{2\,c\,d-b\,e}{2\,q}\right)\int \frac{(f\,x)^m}{\frac{b}{2}+\frac{q}{2}+c\,x^2}\,dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)/(a_+b_.*x_^2+c_.*x_^4),x_Symbol] :=
  With[{q=Rt[b^2-4*a*c,2]},
  (e/2+(2*c*d-b*e)/(2*q))*Int[(f*x)^m/(b/2-q/2+c*x^2),x] + (e/2-(2*c*d-b*e)/(2*q))*Int[(f*x)^m/(b/2+q/2+c*x^2),x]] /;
FreeQ[{a,b,c,d,e,f,m},x] && NeQ[b^2-4*a*c,0]
```

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)/(a_+c_.*x_^4),x_Symbol] :=
  With[{q=Rt[-a*c,2]},
  -(e/2+c*d/(2*q))*Int[(f*x)^m/(q-c*x^2),x] + (e/2-c*d/(2*q))*Int[(f*x)^m/(q+c*x^2),x]] /;
FreeQ[{a,c,d,e,f,m},x]
```

9. $\int \frac{(f\,x)^m \left(d+e\,x^2\right)^q}{a+b\,x^2+c\,x^4}\,dx$ when $b^2-4\,a\,c\neq 0$

  1. $\int \frac{(f\,x)^m \left(d+e\,x^2\right)^q}{a+b\,x^2+c\,x^4}\,dx$ when $b^2-4\,a\,c\neq 0\,\wedge\,q\in\mathbb{Z}$

    1: $\int \frac{(f\,x)^m \left(d+e\,x^2\right)^q}{a+b\,x^2+c\,x^4}\,dx$ when $b^2-4\,a\,c\neq 0\,\wedge\,q\in\mathbb{Z}\,\wedge\,m\in\mathbb{Z}$

Derivation: Algebraic expansion

Rule 1.2.2.4.9.1.1: If $b^2-4\,a\,c\neq 0\,\wedge\,q\in\mathbb{Z}\,\wedge\,m\in\mathbb{Z}$, then

$$\int \frac{(f\,x)^m \left(d+e\,x^2\right)^q}{a+b\,x^2+c\,x^4}\,dx \longrightarrow \int \text{ExpandIntegrand}\left[\frac{(f\,x)^m \left(d+e\,x^2\right)^q}{a+b\,x^2+c\,x^4},\,x\right]dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_./(a_+b_.*x_^2+c_.*x_^4),x_Symbol] :=
  Int[ExpandIntegrand[(f*x)^m*(d+e*x^2)^q/(a+b*x^2+c*x^4),x],x] /;
FreeQ[{a,b,c,d,e,f,m},x] && NeQ[b^2-4*a*c,0] && IntegerQ[q] && IntegerQ[m]
```

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_./(a_+c_.*x_^4),x_Symbol] :=
  Int[ExpandIntegrand[(f*x)^m*(d+e*x^2)^q/(a+c*x^4),x],x] /;
FreeQ[{a,c,d,e,f,m},x] && IntegerQ[q] && IntegerQ[m]
```

2: $\int \frac{(f\,x)^m\,\left(d+e\,x^2\right)^q}{a+b\,x^2+c\,x^4}\,dx$ when $b^2-4\,a\,c\neq 0\,\wedge\,q\in\mathbb{Z}\,\wedge\,m\notin\mathbb{Z}$

Derivation: Algebraic expansion

Rule 1.2.2.4.9.1.2: If $b^2-4\,a\,c\neq 0\,\wedge\,q\in\mathbb{Z}\,\wedge\,m\notin\mathbb{Z}$**, then**

$$\int \frac{(f\,x)^m\,\left(d+e\,x^2\right)^q}{a+b\,x^2+c\,x^4}\,dx\,\longrightarrow\,\int (f\,x)^m\,\text{ExpandIntegrand}\left[\frac{\left(d+e\,x^2\right)^q}{a+b\,x^2+c\,x^4},\,x\right]dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_./(a_+b_.*x_^2+c_.*x_^4),x_Symbol] :=
  Int[ExpandIntegrand[(f*x)^m,(d+e*x^2)^q/(a+b*x^2+c*x^4),x],x] /;
FreeQ[{a,b,c,d,e,f,m},x] && NeQ[b^2-4*a*c,0] && IntegerQ[q] && Not[IntegerQ[m]]
```

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_./(a_+c_.*x_^4),x_Symbol] :=
  Int[ExpandIntegrand[(f*x)^m,(d+e*x^2)^q/(a+c*x^4),x],x] /;
FreeQ[{a,c,d,e,f,m},x] && IntegerQ[q] && Not[IntegerQ[m]]
```

2. $\int \frac{(f x)^m \left(d+e x^2\right)^q}{a+b x^2+c x^4} \, dx$ when $b^2-4 a c \neq 0 \land q \notin \mathbb{Z}$

1. $\int \frac{(f x)^m \left(d+e x^2\right)^q}{a+b x^2+c x^4} \, dx$ when $b^2-4 a c \neq 0 \land q \notin \mathbb{Z} \land q>0$

1. $\int \frac{(f x)^m \left(d+e x^2\right)^q}{a+b x^2+c x^4} \, dx$ when $b^2-4 a c \neq 0 \land q \notin \mathbb{Z} \land q>0 \land m>1$

1: $\int \frac{(f x)^m \left(d+e x^2\right)^q}{a+b x^2+c x^4} \, dx$ when $b^2-4 a c \neq 0 \land q \notin \mathbb{Z} \land q>0 \land m>3$

Reference: Algebraic expansion

- **Basis:** $\frac{d+e z}{a+b z+c z^2} = \frac{c d-b e+c e z}{c^2 z^2} - \frac{a (c d-b e)+\left(b c d-b^2 e+a c e\right) z}{c^2 z^2 \left(a+b z+c z^2\right)}$

- **Rule 1.2.2.4.9.2.1.1.1: If** $b^2-4 a c \neq 0 \land q \notin \mathbb{Z} \land q>0 \land m>3$**, then**

$$\int \frac{(f x)^m \left(d+e x^2\right)^q}{a+b x^2+c x^4} \, dx \rightarrow$$

$$\frac{f^4}{c^2} \int (f x)^{m-4} \left(c d-b e+c e x^2\right) \left(d+e x^2\right)^{q-1} dx - \frac{f^4}{c^2} \int \frac{(f x)^{m-4} \left(d+e x^2\right)^{q-1} \left(a (c d-b e)+\left(b c d-b^2 e+a c e\right) x^2\right)}{a+b x^2+c x^4} \, dx$$

- **Program code:**

```
Int[(f_.*x_)^m_.*(d_.+e_.*x_^2)^q_/(a_+b_.*x_^2+c_.*x_^4),x_Symbol] :=
  f^4/c^2*Int[(f*x)^(m-4)*(c*d-b*e+c*e*x^2)*(d+e*x^2)^(q-1),x] -
  f^4/c^2*Int[(f*x)^(m-4)*(d+e*x^2)^(q-1)*Simp[a*(c*d-b*e)+(b*c*d-b^2*e+a*c*e)*x^2,x]/(a+b*x^2+c*x^4),x] /;
FreeQ[{a,b,c,d,e,f},x] && NeQ[b^2-4*a*c,0] && Not[IntegerQ[q]] && GtQ[q,0] && GtQ[m,3]
```

```
Int[(f_.*x_)^m_.*(d_.+e_.*x_^2)^q_/(a_+c_.*x_^4),x_Symbol] :=
  f^4/c*Int[(f*x)^(m-4)*(d+e*x^2)^q,x] -
  a*f^4/c*Int[(f*x)^(m-4)*(d+e*x^2)^q/(a+c*x^4),x] /;
FreeQ[{a,c,d,e,f,q},x] && Not[IntegerQ[q]] && GtQ[m,3]
```

2: $\int \frac{(f\,x)^m\,\left(d+e\,x^2\right)^q}{a+b\,x^2+c\,x^4}\,dx$ when $b^2-4\,a\,c\neq 0\,\wedge\,q\notin\mathbb{Z}\,\wedge\,q>0\,\wedge\,1<m\leq 3$

Reference: Algebraic expansion

Basis: $\frac{d+e\,z}{a+b\,z+c\,z^2}==\frac{e}{c\,z}-\frac{a\,e-(c\,d-b\,e)\,z}{c\,z\,\left(a+b\,z+c\,z^2\right)}$

Rule 1.2.2.4.9.2.1.1.2: If $b^2-4\,a\,c\neq 0\,\wedge\,q\notin\mathbb{Z}\,\wedge\,q>0\,\wedge\,1<m\leq 3$, **then**

$$\int \frac{(f\,x)^m\,\left(d+e\,x^2\right)^q}{a+b\,x^2+c\,x^4}\,dx\,\longrightarrow\,\frac{e\,f^2}{c}\int (f\,x)^{m-2}\,\left(d+e\,x^2\right)^{q-1}\,dx-\frac{f^2}{c}\int \frac{(f\,x)^{m-2}\,\left(d+e\,x^2\right)^{q-1}\,\left(a\,e-(c\,d-b\,e)\,x^2\right)}{a+b\,x^2+c\,x^4}\,dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_.+e_.*x_^2)^q_/(a_+b_.*x_^2+c_.*x_^4),x_Symbol] :=
  e*f^2/c*Int[(f*x)^(m-2)*(d+e*x^2)^(q-1),x] -
  f^2/c*Int[(f*x)^(m-2)*(d+e*x^2)^(q-1)*Simp[a*e-(c*d-b*e)*x^2,x]/(a+b*x^2+c*x^4),x] /;
FreeQ[{a,b,c,d,e,f},x] && NeQ[b^2-4*a*c,0] && Not[IntegerQ[q]] && GtQ[q,0] && GtQ[m,1] && LeQ[m,3]
```

```
Int[(f_.*x_)^m_.*(d_.+e_.*x_^2)^q_/(a_+c_.*x_^4),x_Symbol] :=
  e*f^2/c*Int[(f*x)^(m-2)*(d+e*x^2)^(q-1),x] -
  f^2/c*Int[(f*x)^(m-2)*(d+e*x^2)^(q-1)*Simp[a*e-c*d*x^2,x]/(a+c*x^4),x] /;
FreeQ[{a,c,d,e,f},x] && Not[IntegerQ[q]] && GtQ[q,0] && GtQ[m,1] && LeQ[m,3]
```

2: $\int \frac{(f x)^m \left(d+e x^2\right)^q}{a+b x^2+c x^4} \, dx$ when $b^2-4 a c \neq 0 \wedge q \notin \mathbb{Z} \wedge q>0 \wedge m<0$

Reference: Algebraic expansion

Basis: $\frac{d+e z}{a+b z+c z^2} == \frac{d}{a} - \frac{z (b d-a e+c d z)}{a (a+b z+c z^2)}$

Rule 1.2.2.4.9.2.1.2: If $b^2-4 a c \neq 0 \wedge q \notin \mathbb{Z} \wedge q>0 \wedge m<0$**, then**

$$\int \frac{(f x)^m \left(d+e x^2\right)^q}{a+b x^2+c x^4} \, dx \longrightarrow \frac{d}{a} \int (f x)^m \left(d+e x^2\right)^{q-1} dx - \frac{1}{a f^2} \int \frac{(f x)^{m+2} \left(d+e x^2\right)^{q-1} \left(b d-a e+c d x^2\right)}{a+b x^2+c x^4} \, dx$$

Program code:

```
Int[(f_.*x_)^m_*(d_.+e_.*x_^2)^q_/(a_+b_.*x_^2+c_.*x_^4),x_Symbol] :=
  d/a*Int[(f*x)^m*(d+e*x^2)^(q-1),x] -
  1/(a*f^2)*Int[(f*x)^(m+2)*(d+e*x^2)^(q-1)*Simp[b*d-a*e+c*d*x^2,x]/(a+b*x^2+c*x^4),x] /;
FreeQ[{a,b,c,d,e,f},x] && NeQ[b^2-4*a*c,0] && Not[IntegerQ[q]] && GtQ[q,0] && LtQ[m,0]
```

```
Int[(f_.*x_)^m_*(d_.+e_.*x_^2)^q_/(a_+c_.*x_^4),x_Symbol] :=
  d/a*Int[(f*x)^m*(d+e*x^2)^(q-1),x] +
  1/(a*f^2)*Int[(f*x)^(m+2)*(d+e*x^2)^(q-1)*Simp[a*e-c*d*x^2,x]/(a+c*x^4),x] /;
FreeQ[{a,c,d,e,f},x] && Not[IntegerQ[q]] && GtQ[q,0] && LtQ[m,0]
```

2. $\int \frac{(f x)^m \left(d+e x^2\right)^q}{a+b x^2+c x^4} \, dx$ when $b^2-4 a c \neq 0 \wedge q \notin \mathbb{Z} \wedge q < -1$

1. $\int \frac{(f x)^m \left(d+e x^2\right)^q}{a+b x^2+c x^4} \, dx$ when $b^2-4 a c \neq 0 \wedge q \notin \mathbb{Z} \wedge q < -1 \wedge m > 1$

1: $\int \frac{(f x)^m \left(d+e x^2\right)^q}{a+b x^2+c x^4} \, dx$ when $b^2-4 a c \neq 0 \wedge q \notin \mathbb{Z} \wedge q < -1 \wedge m > 3$

Reference: Algebraic expansion

Basis: $\frac{1}{a+b z+c z^2} == \frac{d^2}{\left(c d^2-b d e+a e^2\right) z^2} - \frac{(d+e z) \left(a d+(b d-a e) z\right)}{\left(c d^2-b d e+a e^2\right) z^2 \left(a+b z+c z^2\right)}$

Rule 1.2.2.4.9.2.2.1.1: If $b^2-4 a c \neq 0 \wedge q \notin \mathbb{Z} \wedge q < -1 \wedge m > 3$, then

$$\int \frac{(f x)^m \left(d+e x^2\right)^q}{a+b x^2+c x^4} \, dx \longrightarrow \frac{d^2 f^4}{c d^2-b d e+a e^2} \int (f x)^{m-4} \left(d+e x^2\right)^q \, dx - \frac{f^4}{c d^2-b d e+a e^2} \int \frac{(f x)^{m-4} \left(d+e x^2\right)^{q+1} \left(a d+(b d-a e) x^2\right)}{a+b x^2+c x^4} \, dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_.+e_.*x_^2)^q_/(a_+b_.*x_^2+c_.*x_^4),x_Symbol] :=
  d^2*f^4/(c*d^2-b*d*e+a*e^2)*Int[(f*x)^(m-4)*(d+e*x^2)^q,x] -
  f^4/(c*d^2-b*d*e+a*e^2)*Int[(f*x)^(m-4)*(d+e*x^2)^(q+1)*Simp[a*d+(b*d-a*e)*x^2,x]/(a+b*x^2+c*x^4),x] /;
FreeQ[{a,b,c,d,e,f},x] && NeQ[b^2-4*a*c,0] && Not[IntegerQ[q]] && LtQ[q,-1] && GtQ[m,3]
```

```
Int[(f_.*x_)^m_.*(d_.+e_.*x_^2)^q_/(a_+c_.*x_^4),x_Symbol] :=
  d^2*f^4/(c*d^2+a*e^2)*Int[(f*x)^(m-4)*(d+e*x^2)^q,x] -
  a*f^4/(c*d^2+a*e^2)*Int[(f*x)^(m-4)*(d+e*x^2)^(q+1)*(d-e*x^2)/(a+c*x^4),x] /;
FreeQ[{a,c,d,e,f},x] && Not[IntegerQ[q]] && LtQ[q,-1] && GtQ[m,3]
```

2: $\int \frac{(f\,x)^m\,(d+e\,x^2)^q}{a+b\,x^2+c\,x^4}\,dx$ when $b^2-4\,a\,c\neq 0\,\land\,q\notin\mathbb{Z}\,\land\,q<-1\,\land\,1<m\leq 3$

Reference: Algebraic expansion

- **Basis:** $\frac{1}{a+b\,z+c\,z^2}==-\frac{d\,e}{(c\,d^2-b\,d\,e+a\,e^2)\,z}+\frac{(d+e\,z)\,(a\,e+c\,d\,z)}{(c\,d^2-b\,d\,e+a\,e^2)\,z\,(a+b\,z+c\,z^2)}$

- **Rule 1.2.2.4.9.2.2.1.2: If** $b^2-4\,a\,c\neq 0\,\land\,q\notin\mathbb{Z}\,\land\,q<-1\,\land\,1<m\leq 3$, **then**

$$\int \frac{(f\,x)^m\,(d+e\,x^2)^q}{a+b\,x^2+c\,x^4}\,dx\,\longrightarrow\,-\frac{d\,e\,f^2}{c\,d^2-b\,d\,e+a\,e^2}\int (f\,x)^{m-2}\,(d+e\,x^2)^q\,dx+\frac{f^2}{c\,d^2-b\,d\,e+a\,e^2}\int \frac{(f\,x)^{m-2}\,(d+e\,x^2)^{q+1}\,(a\,e+c\,d\,x^2)}{a+b\,x^2+c\,x^4}\,dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_.+e_.*x_^2)^q_/(a_+b_.*x_^2+c_.*x_^4),x_Symbol] :=
  -d*e*f^2/(c*d^2-b*d*e+a*e^2)*Int[(f*x)^(m-2)*(d+e*x^2)^q,x] +
  f^2/(c*d^2-b*d*e+a*e^2)*Int[(f*x)^(m-2)*(d+e*x^2)^(q+1)*Simp[a*e+c*d*x^2,x]/(a+b*x^2+c*x^4),x] /;
FreeQ[{a,b,c,d,e,f},x] && NeQ[b^2-4*a*c,0] && Not[IntegerQ[q]] && LtQ[q,-1] && GtQ[m,1] && LeQ[m,3]
```

```
Int[(f_.*x_)^m_.*(d_.+e_.*x_^2)^q_/(a_+c_.*x_^4),x_Symbol] :=
  -d*e*f^2/(c*d^2+a*e^2)*Int[(f*x)^(m-2)*(d+e*x^2)^q,x] +
  f^2/(c*d^2+a*e^2)*Int[(f*x)^(m-2)*(d+e*x^2)^(q+1)*Simp[a*e+c*d*x^2,x]/(a+c*x^4),x] /;
FreeQ[{a,c,d,e,f},x] && Not[IntegerQ[q]] && LtQ[q,-1] && GtQ[m,1] && LeQ[m,3]
```

2: $\int \frac{(f\,x)^m \left(d+e\,x^2\right)^q}{a+b\,x^2+c\,x^4}\,dx$ when $b^2-4\,a\,c\neq 0\,\bigwedge\,q\notin\mathbb{Z}\,\bigwedge\,q<-1$

Derivation: Algebraic expansion

Basis: $\frac{1}{a+b\,z+c\,z^2}==\frac{e^2}{c\,d^2-b\,d\,e+a\,e^2}+\frac{(d+e\,z)\,(c\,d-b\,e-c\,e\,z)}{(c\,d^2-b\,d\,e+a\,e^2)\,(a+b\,z+c\,z^2)}$

Rule 1.2.2.4.9.2.2.2: If $b^2-4\,a\,c\neq 0\,\bigwedge\,q\notin\mathbb{Z}\,\bigwedge\,q<-1$, then

$$\int \frac{(f\,x)^m \left(d+e\,x^2\right)^q}{a+b\,x^2+c\,x^4}\,dx \longrightarrow \frac{e^2}{c\,d^2-b\,d\,e+a\,e^2}\int (f\,x)^m \left(d+e\,x^2\right)^q dx+\frac{1}{c\,d^2-b\,d\,e+a\,e^2}\int \frac{(f\,x)^m \left(d+e\,x^2\right)^{q+1} \left(c\,d-b\,e-c\,e\,x^2\right)}{a+b\,x^2+c\,x^4}\,dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_/(a_+b_.*x_^2+c_.*x_^4),x_Symbol] :=
  e^2/(c*d^2-b*d*e+a*e^2)*Int[(f*x)^m*(d+e*x^2)^q,x] +
  1/(c*d^2-b*d*e+a*e^2)*Int[(f*x)^m*(d+e*x^2)^(q+1)*Simp[c*d-b*e-c*e*x^2,x]/(a+b*x^2+c*x^4),x] /;
FreeQ[{a,b,c,d,e,f,m},x] && NeQ[b^2-4*a*c,0] && Not[IntegerQ[q]] && LtQ[q,-1]
```

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_/(a_+c_.*x_^4),x_Symbol] :=
  e^2/(c*d^2+a*e^2)*Int[(f*x)^m*(d+e*x^2)^q,x] +
  c/(c*d^2+a*e^2)*Int[(f*x)^m*(d+e*x^2)^(q+1)*(d-e*x^2)/(a+c*x^4),x] /;
FreeQ[{a,c,d,e,f,m},x] && Not[IntegerQ[q]] && LtQ[q,-1]
```

3: $\int \frac{(f\,x)^m\,(d+e\,x^2)^q}{a+b\,x^2+c\,x^4}\,dx$ when $b^2-4\,a\,c\neq 0\,\wedge\,q\notin\mathbb{Z}\,\wedge\,m\in\mathbb{Z}$

Derivation: Algebraic expansion

- **Basis: If** $q=\sqrt{b^2-4\,a\,c}$, **then** $\frac{1}{a+b\,z+c\,z^2}=\frac{2\,c}{q\,(b-q+2\,c\,z)}-\frac{2\,c}{q\,(b+q+2\,c\,z)}$

- **Rule 1.2.2.4.9.2.3: If** $b^2-4\,a\,c\neq 0\,\wedge\,q\notin\mathbb{Z}\,\wedge\,m\in\mathbb{Z}$, **then**

$$\int \frac{(f\,x)^m\,(d+e\,x^2)^q}{a+b\,x^2+c\,x^4}\,dx\;\longrightarrow\;\int (d+e\,x^2)^q\,\text{ExpandIntegrand}\left[\frac{(f\,x)^m}{a+b\,x^2+c\,x^4},\,x\right]dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_/(a_+b_.*x_^2+c_.*x_^4),x_Symbol] :=
  Int[ExpandIntegrand[(d+e*x^2)^q,(f*x)^m/(a+b*x^2+c*x^4),x],x] /;
FreeQ[{a,b,c,d,e,f,q},x] && NeQ[b^2-4*a*c,0] && Not[IntegerQ[q]] && IntegerQ[m]
```

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_/(a_+c_.*x_^4),x_Symbol] :=
  Int[ExpandIntegrand[(d+e*x^2)^q,(f*x)^m/(a+c*x^4),x],x] /;
FreeQ[{a,c,d,e,f,q},x] && Not[IntegerQ[q]] && IntegerQ[m]
```

4: $\int \frac{(f\,x)^m\,(d+e\,x^2)^q}{a+b\,x^2+c\,x^4}\,dx$ when $b^2-4\,a\,c\neq 0\,\wedge\,q\notin\mathbb{Z}\,\wedge\,m\notin\mathbb{Z}$

Derivation: Algebraic expansion

- **Basis: If** $q=\sqrt{b^2-4\,a\,c}$, **then** $\frac{1}{a+b\,z+c\,z^2}=\frac{2\,c}{q\,(b-q+2\,c\,z)}-\frac{2\,c}{q\,(b+q+2\,c\,z)}$

- **Rule 1.2.2.4.9.2.4: If** $b^2-4\,a\,c\neq 0\,\wedge\,q\notin\mathbb{Z}\,\wedge\,m\notin\mathbb{Z}$, **then**

$$\int \frac{(f\,x)^m\,(d+e\,x^2)^q}{a+b\,x^2+c\,x^4}\,dx\;\longrightarrow\;\int (f\,x)^m\,(d+e\,x^2)^q\,\text{ExpandIntegrand}\left[\frac{1}{a+b\,x^2+c\,x^4},\,x\right]dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_/(a_+b_.*x_^2+c_.*x_^4),x_Symbol] :=
  Int[ExpandIntegrand[(f*x)^m*(d+e*x^2)^q,1/(a+b*x^2+c*x^4),x],x] /;
FreeQ[{a,b,c,d,e,f,m,q},x] && NeQ[b^2-4*a*c,0] && Not[IntegerQ[q]] && Not[IntegerQ[m]]
```

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_/(a_+c_.*x_^4),x_Symbol] :=
  Int[ExpandIntegrand[(f*x)^m*(d+e*x^2)^q,1/(a+c*x^4),x],x] /;
FreeQ[{a,c,d,e,f,m,q},x] && Not[IntegerQ[q]] && Not[IntegerQ[m]]
```

10: $\int \frac{(f\,x)^m\,\left(d+e\,x^2\right)^q}{a+b\,x^2+c\,x^4}\,dx$ when $b^2-4\,a\,c\neq 0$

- **Derivation: Algebraic expansion**

- **Basis: If** $r=\sqrt{b^2-4\,a\,c}$, **then** $\frac{1}{a+b\,z+c\,z^2}==\frac{2\,c}{r\,(b-r+2\,c\,z)}-\frac{2\,c}{r\,(b+r+2\,c\,z)}$

- **Rule 1.2.2.4.10: If** $b^2-4\,a\,c\neq 0$, **then**

$$\int \frac{(f\,x)^m\,\left(d+e\,x^2\right)^q}{a+b\,x^2+c\,x^4}\,dx \longrightarrow \frac{2\,c}{r}\int \frac{(f\,x)^m\,\left(d+e\,x^2\right)^q}{b-r+2\,c\,x^2}\,dx-\frac{2\,c}{r}\int \frac{(f\,x)^m\,\left(d+e\,x^2\right)^q}{b+r+2\,c\,x^2}\,dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_/(a_+b_.*x_^2+c_.*x_^4),x_Symbol] :=
  With[{r=Rt[b^2-4*a*c,2]},
  2*c/r*Int[(f*x)^m*(d+e*x^2)^q/(b-r+2*c*x^2),x] - 2*c/r*Int[(f*x)^m*(d+e*x^2)^q/(b+r+2*c*x^2),x]] /;
FreeQ[{a,b,c,d,e,f,m,q},x] && NeQ[b^2-4*a*c,0]
```

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_/(a_+c_.*x_^4),x_Symbol] :=
  With[{r=Rt[-a*c,2]},
  -c/(2*r)*Int[(f*x)^m*(d+e*x^2)^q/(r-c*x^2),x] - c/(2*r)*Int[(f*x)^m*(d+e*x^2)^q/(r+c*x^2),x]] /;
FreeQ[{a,c,d,e,f,m,q},x]
```

11. $\int \frac{(f\,x)^m\,\left(a+b\,x^2+c\,x^4\right)^p}{d+e\,x^2}\,dx$ when $b^2-4\,a\,c\neq 0$

1. $\int \frac{(f\,x)^m\,\left(a+b\,x^2+c\,x^4\right)^p}{d+e\,x^2}\,dx$ when $b^2-4\,a\,c\neq 0\,\wedge\,p>0\,\wedge\,m<0$

1: $\int \frac{(f\,x)^m\,\left(a+b\,x^2+c\,x^4\right)^p}{d+e\,x^2}\,dx$ when $b^2-4\,a\,c\neq 0\,\wedge\,p>0\,\wedge\,m<-2$

Reference: Algebraic expansion

Basis: $\frac{a+b\,z+c\,z^2}{d+e\,z} == \frac{a\,d+(b\,d-a\,e)\,z}{d^2} + \frac{\left(c\,d^2-b\,d\,e+a\,e^2\right)\,z^2}{d^2\,(d+e\,z)}$

Rule 1.2.2.4.11.1.1: If $b^2-4\,a\,c\neq 0\,\wedge\,p>0\,\wedge\,m<-2$**, then**

$$\int \frac{(f\,x)^m\,\left(a+b\,x^2+c\,x^4\right)^p}{d+e\,x^2}\,dx \longrightarrow$$

$$\frac{1}{d^2}\int (f\,x)^m\,\left(a\,d+(b\,d-a\,e)\,x^2\right)\,\left(a+b\,x^2+c\,x^4\right)^{p-1}\,dx+\frac{c\,d^2-b\,d\,e+a\,e^2}{d^2\,f^4}\int \frac{(f\,x)^{m+4}\,\left(a+b\,x^2+c\,x^4\right)^{p-1}}{d+e\,x^2}\,dx$$

Program code:

```
Int[(f_.*x_)^m_*(a_.+b_.*x_^2+c_.*x_^4)^p_./(d_.+e_.*x_^2),x_Symbol] :=
  1/d^2*Int[(f*x)^m*(a*d+(b*d-a*e)*x^2)*(a+b*x^2+c*x^4)^(p-1),x] +
  (c*d^2-b*d*e+a*e^2)/(d^2*f^4)*Int[(f*x)^(m+4)*(a+b*x^2+c*x^4)^(p-1)/(d+e*x^2),x] /;
FreeQ[{a,b,c,d,e,f},x] && NeQ[b^2-4*a*c,0] && GtQ[p,0] && LtQ[m,-2]
```

```
Int[(f_.*x_)^m_*(a_+c_.*x_^4)^p_./(d_.+e_.*x_^2),x_Symbol] :=
  a/d^2*Int[(f*x)^m*(d-e*x^2)*(a+c*x^4)^(p-1),x] +
  (c*d^2+a*e^2)/(d^2*f^4)*Int[(f*x)^(m+4)*(a+c*x^4)^(p-1)/(d+e*x^2),x] /;
FreeQ[{a,c,d,e,f},x] && GtQ[p,0] && LtQ[m,-2]
```

2: $\int \frac{(f\,x)^m\,\left(a+b\,x^2+c\,x^4\right)^p}{d+e\,x^2}\,dx$ when $b^2-4\,a\,c\neq 0\,\wedge\,p>0\,\wedge\,m<0$

Reference: Algebraic expansion

Basis: $\frac{a+b\,z+c\,z^2}{d+e\,z} == \frac{a\,e+c\,d\,z}{d\,e} - \frac{\left(c\,d^2-b\,d\,e+a\,e^2\right)\,z}{d\,e\,(d+e\,z)}$

Rule 1.2.2.4.11.1.2: If $b^2-4\,a\,c\neq 0\,\wedge\,p>0\,\wedge\,m<0$**, then**

$$\int \frac{(f\,x)^m\,\left(a+b\,x^2+c\,x^4\right)^p}{d+e\,x^2}\,dx\,\longrightarrow$$

$$\frac{1}{d\,e}\int (f\,x)^m\,\left(a\,e+c\,d\,x^2\right)\,\left(a+b\,x^2+c\,x^4\right)^{p-1}\,dx-\frac{c\,d^2-b\,d\,e+a\,e^2}{d\,e\,f^2}\int \frac{(f\,x)^{m+2}\,\left(a+b\,x^2+c\,x^4\right)^{p-1}}{d+e\,x^2}\,dx$$

Program code:

```
Int[(f_.*x_)^m_*(a_.+b_.*x_^2+c_.*x_^4)^p_./(d_.+e_.*x_^2),x_Symbol] :=
  1/(d*e)*Int[(f*x)^m*(a*e+c*d*x^2)*(a+b*x^2+c*x^4)^(p-1),x] -
  (c*d^2-b*d*e+a*e^2)/(d*e*f^2)*Int[(f*x)^(m+2)*(a+b*x^2+c*x^4)^(p-1)/(d+e*x^2),x] /;
FreeQ[{a,b,c,d,e,f},x] && NeQ[b^2-4*a*c,0] && GtQ[p,0] && LtQ[m,0]
```

```
Int[(f_.*x_)^m_*(a_+c_.*x_^4)^p_./(d_.+e_.*x_^2),x_Symbol] :=
  1/(d*e)*Int[(f*x)^m*(a*e+c*d*x^2)*(a+c*x^4)^(p-1),x] -
  (c*d^2+a*e^2)/(d*e*f^2)*Int[(f*x)^(m+2)*(a+c*x^4)^(p-1)/(d+e*x^2),x] /;
FreeQ[{a,c,d,e,f},x] && GtQ[p,0] && LtQ[m,0]
```

2. $\int \frac{(f\,x)^m\,\left(a+b\,x^2+c\,x^4\right)^p}{d+e\,x^2}\,dx$ when $b^2-4\,a\,c\neq 0\,\wedge\,p<-1\,\wedge\,m>0$

1: $\int \frac{(f\,x)^m\,\left(a+b\,x^2+c\,x^4\right)^p}{d+e\,x^2}\,dx$ when $b^2-4\,a\,c\neq 0\,\wedge\,p<-1\,\wedge\,m>2$

Reference: Algebraic expansion

Basis: $\frac{z^2}{d+e\,z}==-\frac{a\,d+(b\,d-a\,e)\,z}{c\,d^2-b\,d\,e+a\,e^2}+\frac{d^2\,\left(a+b\,z+c\,z^2\right)}{\left(c\,d^2-b\,d\,e+a\,e^2\right)\,(d+e\,z)}$

Rule 1.2.2.4.11.2.1: If $b^2-4\,a\,c\neq 0\,\wedge\,p<-1\,\wedge\,m>2$, then

$$\int \frac{(f\,x)^m\,\left(a+b\,x^2+c\,x^4\right)^p}{d+e\,x^2}\,dx\,\longrightarrow$$

$$-\frac{f^4}{c\,d^2-b\,d\,e+a\,e^2}\int (f\,x)^{m-4}\,\left(a\,d+(b\,d-a\,e)\,x^2\right)\,\left(a+b\,x^2+c\,x^4\right)^p\,dx+\frac{d^2\,f^4}{c\,d^2-b\,d\,e+a\,e^2}\int \frac{(f\,x)^{m-4}\,\left(a+b\,x^2+c\,x^4\right)^{p+1}}{d+e\,x^2}\,dx$$

Program code:

```
Int[(f_.*x_)^m_.*(a_.+b_.*x_^2+c_.*x_^4)^p_/(d_.+e_.*x_^2),x_Symbol] :=
  -f^4/(c*d^2-b*d*e+a*e^2)*Int[(f*x)^(m-4)*(a*d+(b*d-a*e)*x^2)*(a+b*x^2+c*x^4)^p,x] +
  d^2*f^4/(c*d^2-b*d*e+a*e^2)*Int[(f*x)^(m-4)*(a+b*x^2+c*x^4)^(p+1)/(d+e*x^2),x] /;
FreeQ[{a,b,c,d,e,f},x] && NeQ[b^2-4*a*c,0] && LtQ[p,-1] && GtQ[m,2]
```

```
Int[(f_.*x_)^m_.*(a_+c_.*x_^4)^p_/(d_.+e_.*x_^2),x_Symbol] :=
  -a*f^4/(c*d^2+a*e^2)*Int[(f*x)^(m-4)*(d-e*x^2)*(a+c*x^4)^p,x] +
  d^2*f^4/(c*d^2+a*e^2)*Int[(f*x)^(m-4)*(a+c*x^4)^(p+1)/(d+e*x^2),x] /;
FreeQ[{a,c,d,e,f},x] && LtQ[p,-1] && GtQ[m,2]
```

2: $\int \frac{(f x)^m \left(a+b x^2+c x^4\right)^p}{d+e x^2} \, dx$ when $b^2-4 a c \neq 0 \wedge p<-1 \wedge m>0$

Reference: Algebraic expansion

Basis: $\frac{z}{d+e z} = \frac{a e+c d z}{c d^2-b d e+a e^2} - \frac{d e \left(a+b z+c z^2\right)}{\left(c d^2-b d e+a e^2\right) (d+e z)}$

Rule 1.2.2.4.11.2.2: If $b^2-4 a c \neq 0 \wedge p<-1 \wedge m>0$, then

$$\int \frac{(f x)^m \left(a+b x^2+c x^4\right)^p}{d+e x^2} \, dx \longrightarrow$$

$$\frac{f^2}{c d^2-b d e+a e^2} \int (f x)^{m-2} \left(a e+c d x^2\right) \left(a+b x^2+c x^4\right)^p \, dx - \frac{d e f^2}{c d^2-b d e+a e^2} \int \frac{(f x)^{m-2} \left(a+b x^2+c x^4\right)^{p+1}}{d+e x^2} \, dx$$

Program code:

```
Int[(f_.*x_)^m_.*(a_.+b_.*x_^2+c_.*x_^4)^p_/(d_.+e_.*x_^2),x_Symbol] :=
  f^2/(c*d^2-b*d*e+a*e^2)*Int[(f*x)^(m-2)*(a*e+c*d*x^2)*(a+b*x^2+c*x^4)^p,x] -
  d*e*f^2/(c*d^2-b*d*e+a*e^2)*Int[(f*x)^(m-2)*(a+b*x^2+c*x^4)^(p+1)/(d+e*x^2),x] /;
FreeQ[{a,b,c,d,e,f},x] && NeQ[b^2-4*a*c,0] && LtQ[p,-1] && GtQ[m,0]
```

```
Int[(f_.*x_)^m_.*(a_+c_.*x_^4)^p_/(d_.+e_.*x_^2),x_Symbol] :=
  f^2/(c*d^2+a*e^2)*Int[(f*x)^(m-2)*(a*e+c*d*x^2)*(a+c*x^4)^p,x] -
  d*e*f^2/(c*d^2+a*e^2)*Int[(f*x)^(m-2)*(a+c*x^4)^(p+1)/(d+e*x^2),x] /;
FreeQ[{a,c,d,e,f},x] && LtQ[p,-1] && GtQ[m,0]
```

3. $\int \frac{x^m}{\left(d+e x^2\right) \sqrt{a+b x^2+c x^4}} \, dx$ when $b^2-4 a c \neq 0 \wedge \frac{m}{2} \in \mathbb{Z}$

1. $\int \frac{x^m}{\left(d+e x^2\right) \sqrt{a+b x^2+c x^4}} \, dx$ when $b^2-4 a c \neq 0 \wedge \frac{m}{2} \in \mathbb{Z}^+$

1. $\int \frac{x^2}{(d+e x^2)\sqrt{a+b x^2+c x^4}}\,dx$ when $b^2-4 a c \neq 0$

1: $\int \frac{x^2}{(d+e x^2)\sqrt{a+b x^2+c x^4}}\,dx$ when $b^2-4 a c \neq 0 \bigwedge c d^2-b d e+a e^2 \neq 0 \bigwedge \frac{c}{a}>0 \bigwedge c d^2-a e^2 == 0$

Derivation: Algebraic expansion

Rule 1.2.2.4.11.3.1.1.1: If $b^2-4 a c \neq 0 \bigwedge c d^2-b d e+a e^2 \neq 0 \bigwedge \frac{c}{a}>0 \bigwedge c d^2-a e^2 == 0$**, then**

$$\int \frac{x^2}{(d+e x^2)\sqrt{a+b x^2+c x^4}}\,dx \to \frac{d}{2 d e}\int \frac{1}{\sqrt{a+b x^2+c x^4}}\,dx-\frac{d}{2 d e}\int \frac{d-e x^2}{(d+e x^2)\sqrt{a+b x^2+c x^4}}\,dx$$

Program code:

```
Int[x_^2/((d_+e_.*x_^2)*Sqrt[a_+b_.*x_^2+c_.*x_^4]),x_Symbol] :=
  d/(2*d*e)*Int[1/Sqrt[a+b*x^2+c*x^4],x] -
  d/(2*d*e)*Int[(d-e*x^2)/((d+e*x^2)*Sqrt[a+b*x^2+c*x^4]),x] /;
FreeQ[{a,b,c,d,e},x] && NeQ[b^2-4*a*c,0] && NeQ[c*d^2-b*d*e+a*e^2,0] && PosQ[c/a] && EqQ[c*d^2-a*e^2,0]
```

```
Int[x_^2/((d_+e_.*x_^2)*Sqrt[a_+c_.*x_^4]),x_Symbol] :=
  d/(2*d*e)*Int[1/Sqrt[a+c*x^4],x] -
  d/(2*d*e)*Int[(d-e*x^2)/((d+e*x^2)*Sqrt[a+c*x^4]),x] /;
FreeQ[{a,c,d,e},x] && NeQ[c*d^2+a*e^2,0] && PosQ[c/a] && EqQ[c*d^2-a*e^2,0]
```

2: $\int \frac{x^2}{\left(d+e\,x^2\right)\sqrt{a+b\,x^2+c\,x^4}}\,dx$ when $b^2-4\,a\,c\neq 0\ \bigwedge\ c\,d^2-b\,d\,e+a\,e^2\neq 0\ \bigwedge\ \frac{c}{a}>0\ \bigwedge\ c\,d^2-a\,e^2\neq 0$

Derivation: Algebraic expansion

- **Basis:** $\frac{x^2}{d+e\,x^2}==\frac{1}{e-d\,q}-\frac{d\,(1+q\,x^2)}{(e-d\,q)\,(d+e\,x^2)}$
- **Rule 1.2.2.4.11.3.1.1.2: If** $b^2-4\,a\,c\neq 0\ \bigwedge\ c\,d^2-b\,d\,e+a\,e^2\neq 0\ \bigwedge\ \frac{c}{a}>0\ \bigwedge\ c\,d^2-a\,e^2\neq 0$**, let** $q\to\sqrt{\frac{c}{a}}$**, then**

$$\int \frac{x^2}{\left(d+e\,x^2\right)\sqrt{a+b\,x^2+c\,x^4}}\,dx\ \longrightarrow\ -\frac{a\,(e+d\,q)}{c\,d^2-a\,e^2}\int \frac{1}{\sqrt{a+b\,x^2+c\,x^4}}\,dx+\frac{a\,d\,(e+d\,q)}{c\,d^2-a\,e^2}\int \frac{1+q\,x^2}{\left(d+e\,x^2\right)\sqrt{a+b\,x^2+c\,x^4}}\,dx$$

Program code:

```
Int[x_^2/((d_+e_.*x_^2)*Sqrt[a_+b_.*x_^2+c_.*x_^4]),x_Symbol] :=
  With[{q=Rt[c/a,2]},
  -a*(e+d*q)/(c*d^2-a*e^2)*Int[1/Sqrt[a+b*x^2+c*x^4],x] +
  a*d*(e+d*q)/(c*d^2-a*e^2)*Int[(1+q*x^2)/((d+e*x^2)*Sqrt[a+b*x^2+c*x^4]),x]] /;
FreeQ[{a,b,c,d,e},x] && NeQ[b^2-4*a*c,0] && NeQ[c*d^2-b*d*e+a*e^2,0] && PosQ[c/a] && NeQ[c*d^2-a*e^2,0]
```

```
Int[x_^2/((d_+e_.*x_^2)*Sqrt[a_+c_.*x_^4]),x_Symbol] :=
  With[{q=Rt[c/a,2]},
  -a*(e+d*q)/(c*d^2-a*e^2)*Int[1/Sqrt[a+c*x^4],x] +
  a*d*(e+d*q)/(c*d^2-a*e^2)*Int[(1+q*x^2)/((d+e*x^2)*Sqrt[a+c*x^4]),x]] /;
FreeQ[{a,c,d,e},x] && NeQ[c*d^2+a*e^2,0] && PosQ[c/a] && NeQ[c*d^2-a*e^2,0]
```

2. $\int \frac{x^4}{\left(d+e x^2\right) \sqrt{a+b x^2+c x^4}} \, dx$ when $b^2-4 a c \neq 0 \bigwedge \frac{c}{a}>0$

1: $\int \frac{x^4}{\left(d+e x^2\right) \sqrt{a+b x^2+c x^4}} \, dx$ when $b^2-4 a c \neq 0 \bigwedge \frac{c}{a}>0 \bigwedge c d^2-a e^2==0$

- **Derivation: Algebraic expansion**

- **Rule 1.2.2.4.11.3.1.2.1: If** $b^2-4 a c \neq 0 \bigwedge \frac{c}{a}>0 \bigwedge c d^2-a e^2==0$**, then**

$$\int \frac{x^4}{\left(d+e x^2\right) \sqrt{a+b x^2+c x^4}} \, dx \longrightarrow -\frac{1}{e^2} \int \frac{d-e x^2}{\sqrt{a+b x^2+c x^4}} \, dx+\frac{d^2}{e^2} \int \frac{1}{\left(d+e x^2\right) \sqrt{a+b x^2+c x^4}} \, dx$$

Program code:

```
Int[x_^4/((d_+e_.*x_^2)*Sqrt[a_+b_.*x_^2+c_.*x_^4]),x_Symbol] :=
  -1/e^2*Int[(d-e*x^2)/Sqrt[a+b*x^2+c*x^4],x] + d^2/e^2*Int[1/((d+e*x^2)*Sqrt[a+b*x^2+c*x^4]),x] /;
FreeQ[{a,b,c,d,e},x] && NeQ[b^2-4*a*c,0] && PosQ[c/a] && EqQ[c*d^2-a*e^2,0]
```

```
Int[x_^4/((d_+e_.*x_^2)*Sqrt[a_+c_.*x_^4]),x_Symbol] :=
  -1/e^2*Int[(d-e*x^2)/Sqrt[a+c*x^4],x] + d^2/e^2*Int[1/((d+e*x^2)*Sqrt[a+c*x^4]),x] /;
FreeQ[{a,c,d,e},x] && PosQ[c/a] && EqQ[c*d^2-a*e^2,0]
```

2: $\int \frac{x^4}{(d+e x^2)\sqrt{a+b x^2+c x^4}}\,dx$ when $b^2-4 a c \neq 0 \bigwedge \frac{c}{a}>0 \bigwedge c d^2-a e^2 \neq 0$

Derivation: Algebraic expansion

- **Rule 1.2.2.4.11.3.1.2.2: If** $b^2-4 a c \neq 0 \bigwedge \frac{c}{a}>0 \bigwedge c d^2-a e^2 \neq 0$**, let** $q \to \sqrt{\frac{c}{a}}$**, then**

$$\int \frac{x^4}{(d+e x^2)\sqrt{a+b x^2+c x^4}}\,dx \longrightarrow$$

$$-\frac{2 c d-a e q}{c e (e-d q)}\int \frac{1}{\sqrt{a+b x^2+c x^4}}\,dx-\frac{1}{e q}\int \frac{1-q x^2}{\sqrt{a+b x^2+c x^4}}\,dx+\frac{d^2}{e (e-d q)}\int \frac{1+q x^2}{(d+e x^2)\sqrt{a+b x^2+c x^4}}\,dx$$

Program code:

```
Int[x_^4/((d_+e_.*x_^2)*Sqrt[a_+b_.*x_^2+c_.*x_^4]),x_Symbol] :=
  With[{q=Rt[c/a,2]},
  -1/(e*q)*Int[(1-q*x^2)/Sqrt[a+b*x^2+c*x^4],x] +
  d^2/(e*(e-d*q))*Int[(1+q*x^2)/((d+e*x^2)*Sqrt[a+b*x^2+c*x^4]),x] /;
 EqQ[2*c*d-a*e*q,0]] /;
FreeQ[{a,b,c,d,e},x] && NeQ[b^2-4*a*c,0] && PosQ[c/a] && NeQ[c*d^2-a*e^2,0]
```

```
Int[x_^4/((d_+e_.*x_^2)*Sqrt[a_+c_.*x_^4]),x_Symbol] :=
  With[{q=Rt[c/a,2]},
  -1/(e*q)*Int[(1-q*x^2)/Sqrt[a+c*x^4],x] +
  d^2/(e*(e-d*q))*Int[(1+q*x^2)/((d+e*x^2)*Sqrt[a+c*x^4]),x] /;
 EqQ[2*c*d-a*e*q,0]] /;
FreeQ[{a,c,d,e},x] && PosQ[c/a] && NeQ[c*d^2-a*e^2,0]
```

```
Int[x_^4/((d_+e_.*x_^2)*Sqrt[a_+b_.*x_^2+c_.*x_^4]),x_Symbol] :=
  With[{q=Rt[c/a,2]},
  -(2*c*d-a*e*q)/(c*e*(e-d*q))*Int[1/Sqrt[a+b*x^2+c*x^4],x] -
  1/(e*q)*Int[(1-q*x^2)/Sqrt[a+b*x^2+c*x^4],x] +
  d^2/(e*(e-d*q))*Int[(1+q*x^2)/((d+e*x^2)*Sqrt[a+b*x^2+c*x^4]),x]] /;
FreeQ[{a,b,c,d,e},x] && NeQ[b^2-4*a*c,0] && PosQ[c/a] && NeQ[c*d^2-a*e^2,0]
```

```
Int[x_^4/((d_+e_.*x_^2)*Sqrt[a_+c_.*x_^4]),x_Symbol] :=
  With[{q=Rt[c/a,2]},
  -(2*c*d-a*e*q)/(c*e*(e-d*q))*Int[1/Sqrt[a+c*x^4],x] -
  1/(e*q)*Int[(1-q*x^2)/Sqrt[a+c*x^4],x] +
  d^2/(e*(e-d*q))*Int[(1+q*x^2)/((d+e*x^2)*Sqrt[a+c*x^4]),x]] /;
FreeQ[{a,c,d,e},x] && PosQ[c/a] && NeQ[c*d^2-a*e^2,0]
```

3: $\int \frac{x^m}{(d+e x^2)\sqrt{a+b x^2+c x^4}}\,dx$ when $b^2-4ac\neq 0\bigwedge\frac{m}{2}-2\in\mathbb{Z}^+$

- **Rule 1.2.2.4.11.3.1.3: If $b^2-4ac\neq 0\bigwedge\frac{m}{2}-2\in\mathbb{Z}^+$, then**

$$\int \frac{x^m}{(d+e x^2)\sqrt{a+b x^2+c x^4}}\,dx\ \longrightarrow$$

$$\frac{x^{m-5}\sqrt{a+b x^2+c x^4}}{c e (m-3)}-\frac{1}{c e (m-3)}\int \left(x^{m-6}\left(a d (m-5)+(a e (m-5)+b d (m-4))x^2+(b e (m-4)+c d (m-3))x^4\right)\right)\Big/\left(\left(d+e x^2\right)\sqrt{a+b x^2+c x^4}\right)dx$$

Program code:

```
Int[x_^m_/((d_+e_.*x_^2)*Sqrt[a_+b_.*x_^2+c_.*x_^4]),x_Symbol] :=
  x^(m-5)*Sqrt[a+b*x^2+c*x^4]/(c*e*(m-3)) -
  1/(c*e*(m-3))*Int[x^(m-6)/((d+e*x^2)*Sqrt[a+b*x^2+c*x^4])*
    Simp[a*d*(m-5)+(a*e*(m-5)+b*d*(m-4))*x^2+(b*e*(m-4)+c*d*(m-3))*x^4,x],x] /;
FreeQ[{a,b,c,d,e},x] && NeQ[b^2-4*a*c,0] && IGtQ[m/2,2]
```

```
Int[x_^m_/((d_+e_.*x_^2)*Sqrt[a_+c_.*x_^4]),x_Symbol] :=
  x^(m-5)*Sqrt[a+c*x^4]/(c*e*(m-3)) -
  1/(c*e*(m-3))*Int[x^(m-6)/((d+e*x^2)*Sqrt[a+c*x^4])*Simp[a*d*(m-5)+a*e*(m-5)*x^2+c*d*(m-3)*x^4,x],x] /;
FreeQ[{a,c,d,e},x] && IGtQ[m/2,2]
```

2: $\int \frac{x^m}{(d+e x^2)\sqrt{a+b x^2+c x^4}}\,dx$ when $b^2-4ac\neq 0\bigwedge\frac{m}{2}\in\mathbb{Z}^-$

- **Rule 1.2.2.4.11.3.2: If $b^2-4ac\neq 0\bigwedge\frac{m}{2}\in\mathbb{Z}^-$, then**

$$\int \frac{x^m}{(d+e x^2)\sqrt{a+b x^2+c x^4}}\,dx\ \longrightarrow$$

$$\frac{x^{m+1}\sqrt{a+b\,x^2+c\,x^4}}{a\,d\,(m+1)}-\frac{1}{a\,d\,(m+1)}\int\frac{x^{m+2}\left(a\,e\,(m+1)+b\,d\,(m+2)+(b\,e\,(m+2)+c\,d\,(m+3))\,x^2+c\,e\,(m+3)\,x^4\right)}{\left(d+e\,x^2\right)\sqrt{a+b\,x^2+c\,x^4}}\,dx$$

–

Program code:

```
Int[x_^m_/((d_+e_.*x_^2)*Sqrt[a_+b_.*x_^2+c_.*x_^4]),x_Symbol] :=
  x^(m+1)*Sqrt[a+b*x^2+c*x^4]/(a*d*(m+1)) -
  1/(a*d*(m+1))*Int[x^(m+2)/((d+e*x^2)*Sqrt[a+b*x^2+c*x^4])*
    Simp[a*e*(m+1)+b*d*(m+2)+(b*e*(m+2)+c*d*(m+3))*x^2+c*e*(m+3)*x^4,x],x] /;
FreeQ[{a,b,c,d,e},x] && NeQ[b^2-4*a*c,0] && ILtQ[m/2,0]
```

```
Int[x_^m_/((d_+e_.*x_^2)*Sqrt[a_+c_.*x_^4]),x_Symbol] :=
  x^(m+1)*Sqrt[a+c*x^4]/(a*d*(m+1)) -
  1/(a*d*(m+1))*Int[x^(m+2)/((d+e*x^2)*Sqrt[a+c*x^4])*Simp[a*e*(m+1)+c*d*(m+3)*x^2+c*e*(m+3)*x^4,x],x] /;
FreeQ[{a,c,d,e},x] && ILtQ[m/2,0]
```

12: $\int \frac{x^m}{\sqrt{d+e x^2}\,\sqrt{a+b x^2+c x^4}}\,dx$ when $b^2-4ac\neq 0 \bigwedge \frac{m}{2}\in\mathbb{Z}$

Derivation: Piecewise constant extraction

- **Basis:** $\partial_x \frac{x\sqrt{e+\frac{d}{x^2}}}{\sqrt{d+e x^2}} == 0$
- **Basis:** $\partial_x \frac{x^2\sqrt{c+\frac{b}{x^2}+\frac{a}{x^4}}}{\sqrt{a+b x^2+c x^4}} == 0$
- **Note: Since $m-3$ is odd, the resulting integrand can be reduced to an integrand of the form $\frac{1}{x^{m/2}\sqrt{e+d x}\,\sqrt{c+b x+a x^2}}$ using the substitution $x\to\frac{1}{x^2}$.**
- **Rule 1.2.2.4.12: If $b^2-4ac\neq 0 \bigwedge \frac{m}{2}\in\mathbb{Z}$, then**

$$\int \frac{x^m}{\sqrt{d+e x^2}\,\sqrt{a+b x^2+c x^4}}\,dx \to \frac{x^3\sqrt{e+\frac{d}{x^2}}\,\sqrt{c+\frac{b}{x^2}+\frac{a}{x^4}}}{\sqrt{d+e x^2}\,\sqrt{a+b x^2+c x^4}}\int \frac{x^{m-3}}{\sqrt{e+\frac{d}{x^2}}\,\sqrt{c+\frac{b}{x^2}+\frac{a}{x^4}}}\,dx$$

Program code:

```
Int[x_^m_/(Sqrt[d_+e_.*x_^2]*Sqrt[a_+b_.*x_^2+c_.*x_^4]),x_Symbol] :=
  x^3*Sqrt[e+d/x^2]*Sqrt[c+b/x^2+a/x^4]/(Sqrt[d+e*x^2]*Sqrt[a+b*x^2+c*x^4])*
    Int[x^(m-3)/(Sqrt[e+d/x^2]*Sqrt[c+b/x^2+a/x^4]),x] /;
FreeQ[{a,b,c,d,e},x] && NeQ[b^2-4*a*c,0] && IntegerQ[m/2]
```

```
Int[x_^m_/(Sqrt[d_+e_.*x_^2]*Sqrt[a_+c_.*x_^4]),x_Symbol] :=
  x^3*Sqrt[e+d/x^2]*Sqrt[c+a/x^4]/(Sqrt[d+e*x^2]*Sqrt[a+c*x^4])*
    Int[x^(m-3)/(Sqrt[e+d/x^2]*Sqrt[c+a/x^4]),x] /;
FreeQ[{a,c,d,e},x] && IntegerQ[m/2]
```

13. $\int x^m \left(d+e x^2\right)^q \left(a+b x^2+c x^4\right)^p dx$ when $b^2-4 a c\neq 0 \bigwedge p<-1 \bigwedge q-1\in\mathbb{Z}^+ \bigwedge \frac{m}{2}\in\mathbb{Z}$

1: $\int x^m \left(d+e x^2\right)^q \left(a+b x^2+c x^4\right)^p dx$ when $b^2-4 a c\neq 0 \bigwedge p<-1 \bigwedge q-1\in\mathbb{Z}^+ \bigwedge \frac{m}{2}\in\mathbb{Z}^+$

Derivation: Algebraic expansion and trinomial recurrence 2b

Rule 1.2.2.4.13.1: If $b^2-4 a c\neq 0 \bigwedge p<-1 \bigwedge q-1\in\mathbb{Z}^+ \bigwedge \frac{m}{2}\in\mathbb{Z}^+$,
let $Q[x]\to \text{PolynomialQuotient}\left[x^m \left(d+e x^2\right)^q,\ a+b x^2+c x^4,\ x\right]$ **and**
$f+g x^2\to \text{PolynomialRemainder}\left[x^m \left(d+e x^2\right)^q,\ a+b x^2+c x^4,\ x\right]$, **then**

$$\int x^m \left(d+e x^2\right)^q \left(a+b x^2+c x^4\right)^p dx \longrightarrow$$

$$\int \left(f+g x^2\right) \left(a+b x^2+c x^4\right)^p dx+\int Q[x] \left(a+b x^2+c x^4\right)^{p+1} dx \longrightarrow$$

$$\frac{x \left(a+b x^2+c x^4\right)^{p+1} \left(a b g-f \left(b^2-2 a c\right)-c\,(b f-2 a g)\, x^2\right)}{2 a\,(p+1) \left(b^2-4 a c\right)}+$$
$$\frac{1}{2 a\,(p+1) \left(b^2-4 a c\right)}\int \left(a+b x^2+c x^4\right)^{p+1}\cdot$$
$$\left(2 a\,(p+1) \left(b^2-4 a c\right) Q[x]+b^2 f\,(2 p+3)-2 a c f\,(4 p+5)-a b g+c\,(4 p+7)\,(b f-2 a g)\, x^2\right) dx$$

Program code:

```
Int[x_^m_*(d_+e_.*x_^2)^q_*(a_+b_.*x_^2+c_.*x_^4)^p_,x_Symbol] :=
  With[{f=Coeff[PolynomialRemainder[x^m*(d+e*x^2)^q,a+b*x^2+c*x^4,x],x,0],
        g=Coeff[PolynomialRemainder[x^m*(d+e*x^2)^q,a+b*x^2+c*x^4,x],x,2]},
  x*(a+b*x^2+c*x^4)^(p+1)*(a*b*g-f*(b^2-2*a*c)-c*(b*f-2*a*g)*x^2)/(2*a*(p+1)*(b^2-4*a*c)) +
   1/(2*a*(p+1)*(b^2-4*a*c))*Int[(a+b*x^2+c*x^4)^(p+1)*
    Simp[ExpandToSum[2*a*(p+1)*(b^2-4*a*c)*PolynomialQuotient[x^m*(d+e*x^2)^q,a+b*x^2+c*x^4,x]+
      b^2*f*(2*p+3)-2*a*c*f*(4*p+5)-a*b*g+c*(4*p+7)*(b*f-2*a*g)*x^2,x],x],x]] /;
FreeQ[{a,b,c,d,e},x] && NeQ[b^2-4*a*c,0] && LtQ[p,-1] && IGtQ[q,1] && IGtQ[m/2,0]
```

2: $\int x^m \left(d+e x^2\right)^q \left(a+b x^2+c x^4\right)^p dx$ when $b^2-4 a c \neq 0 \bigwedge p<-1 \bigwedge q-1 \in \mathbb{Z}^+ \bigwedge \frac{m}{2} \in \mathbb{Z}^-$

Derivation: Algebraic expansion and trinomial recurrence 2b

Rule 1.2.2.4.13.2: If $b^2-4 a c \neq 0 \bigwedge p<-1 \bigwedge q-1 \in \mathbb{Z}^+ \bigwedge \frac{m}{2} \in \mathbb{Z}^-$,
let $Q[x] \rightarrow \text{PolynomialQuotient}\left[x^m \left(d+e x^2\right)^q, a+b x^2+c x^4, x\right]$ **and**
$f+g x^2 \rightarrow \text{PolynomialRemainder}\left[x^m \left(d+e x^2\right)^q, a+b x^2+c x^4, x\right]$**, then**

$$\int x^m \left(d+e x^2\right)^q \left(a+b x^2+c x^4\right)^p dx \longrightarrow$$

$$\int \left(f+g x^2\right) \left(a+b x^2+c x^4\right)^p dx+\int Q[x] \left(a+b x^2+c x^4\right)^{p+1} dx \longrightarrow$$

$$\frac{x \left(a+b x^2+c x^4\right)^{p+1} \left(a b g-f \left(b^2-2 a c\right)-c (b f-2 a g) x^2\right)}{2 a (p+1) \left(b^2-4 a c\right)}+$$
$$\frac{1}{2 a (p+1) \left(b^2-4 a c\right)} \int x^m \left(a+b x^2+c x^4\right)^{p+1} \cdot$$
$$\left(2 a (p+1) \left(b^2-4 a c\right) x^{-m} Q[x]+\left(b^2 f (2 p+3)-2 a c f (4 p+5)-a b g\right) x^{-m}+c (4 p+7) (b f-2 a g) x^{2-m}\right) dx$$

Program code:

```
Int[x_^m_*(d_+e_.*x_^2)^q_*(a_+b_.*x_^2+c_.*x_^4)^p_,x_Symbol] :=
  With[{f=Coeff[PolynomialRemainder[x^m*(d+e*x^2)^q,a+b*x^2+c*x^4,x],x,0],
        g=Coeff[PolynomialRemainder[x^m*(d+e*x^2)^q,a+b*x^2+c*x^4,x],x,2]},
  x*(a+b*x^2+c*x^4)^(p+1)*(a*b*g-f*(b^2-2*a*c)-c*(b*f-2*a*g)*x^2)/(2*a*(p+1)*(b^2-4*a*c)) +
   1/(2*a*(p+1)*(b^2-4*a*c))*Int[x^m*(a+b*x^2+c*x^4)^(p+1)*
    Simp[ExpandToSum[2*a*(p+1)*(b^2-4*a*c)*x^(-m)*PolynomialQuotient[x^m*(d+e*x^2)^q,a+b*x^2+c*x^4,x]+
      (b^2*f*(2*p+3)-2*a*c*f*(4*p+5)-a*b*g)*x^(-m)+c*(4*p+7)*(b*f-2*a*g)*x^(2-m),x],x],x]] /;
FreeQ[{a,b,c,d,e},x] && NeQ[b^2-4*a*c,0] && LtQ[p,-1] && IGtQ[q,1] && ILtQ[m/2,0]
```

14: $\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p dx$ when $b^2-4\,a\,c\neq 0 \wedge (p\in\mathbb{Z}^+ \vee q\in\mathbb{Z}^+ \vee (m\mid q)\in\mathbb{Z})$

Derivation: Algebraic expansion

- **Rule 1.2.2.4.14: If** $b^2-4\,a\,c\neq 0 \wedge (p\in\mathbb{Z}^+ \vee q\in\mathbb{Z}^+ \vee (m\mid q)\in\mathbb{Z})$**, then**

$$\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p dx \longrightarrow \int \text{ExpandIntegrand}\left[(f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p,\ x\right] dx$$

Program code:

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_.*(a_+b_.*x_^2+c_.*x_^4)^p_.,x_Symbol] :=
  Int[ExpandIntegrand[(f*x)^m*(d+e*x^2)^q*(a+b*x^2+c*x^4)^p,x],x] /;
FreeQ[{a,b,c,d,e,f,m,p,q},x] && NeQ[b^2-4*a*c,0] && (IGtQ[p,0] || IGtQ[q,0] || IntegersQ[m,q])
```

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_.*(a_+c_.*x_^4)^p_.,x_Symbol] :=
  Int[ExpandIntegrand[(f*x)^m*(d+e*x^2)^q*(a+c*x^4)^p,x],x] /;
FreeQ[{a,c,d,e,f,m,p,q},x] && (IGtQ[p,0] || IGtQ[q,0] || IntegersQ[m,q])
```

15: $\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+c\,x^4\right)^p dx$ when $p\notin\mathbb{Z} \wedge q\in\mathbb{Z}^-$

- **Derivation: Algebraic expansion**
- **Basis: If** $q\in\mathbb{Z}$**, then** $\left(d+e\,x^2\right)^q = \left(\frac{d}{d^2-e^2\,x^4}-\frac{e\,x^2}{d^2-e^2\,x^4}\right)^{-q}$
- **Note: Resulting integrands are of the form** $x^m \left(a+b\,x^2\right)^p \left(c+d\,x^2\right)^q$ **which are integrable.**
- **Rule 1.2.2.4.15: If** $p\notin\mathbb{Z} \wedge q\in\mathbb{Z}^-$**, then**

$$\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+c\,x^4\right)^p dx \longrightarrow \frac{(f\,x)^m}{x^m}\int x^m \left(a+c\,x^4\right)^p \text{ExpandIntegrand}\left[\left(\frac{d}{d^2-e^2\,x^4}-\frac{e\,x^2}{d^2-e^2\,x^4}\right)^{-q},\ x\right] dx$$

- **Program code:**

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_*(a_+c_.*x_^4)^p_,x_Symbol] :=
  (f*x)^m/x^m*Int[ExpandIntegrand[x^m*(a+c*x^4)^p,(d/(d^2-e^2*x^4)-e*x^2/(d^2-e^2*x^4))^(-q),x],x] /;
FreeQ[{a,c,d,e,f,m,p},x] && Not[IntegerQ[p]] && ILtQ[q,0]
```

U: $\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p\,dx$

- **Rule 1.2.2.4.U:**

$$\int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p\,dx \longrightarrow \int (f\,x)^m \left(d+e\,x^2\right)^q \left(a+b\,x^2+c\,x^4\right)^p\,dx$$

- **Program code:**

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_.*(a_+b_.*x_^2+c_.*x_^4)^p_.,x_Symbol] :=
  Unintegrable[(f*x)^m*(d+e*x^2)^q*(a+b*x^2+c*x^4)^p,x] /;
FreeQ[{a,b,c,d,e,f,m,p,q},x]
```

```
Int[(f_.*x_)^m_.*(d_+e_.*x_^2)^q_.*(a_+c_.*x_^4)^p_.,x_Symbol] :=
  Unintegrable[(f*x)^m*(d+e*x^2)^q*(a+c*x^4)^p,x] /;
FreeQ[{a,c,d,e,f,m,p,q},x]
```