```
In[]:= ρ := z1 + Z1 - z2 Z2 - G z3^2 Z2^2 - z3 Z3 - g z2^2 Z3^2 - a (z2^2 Z2^2 - 4 z2 z3 Z2 Z3 + z3^2 Z3^2)

In[]:= ρ2

Out[]= ρ2

In[]:= ρ2 := D[ρ, z2]

In[]:= eho2

Out[]= 2 eho

In[]:= ρ2

Out[]= -Z2 - 2 g z2 Z3^2 - a (2 z2 Z2^2 - 4 z3 Z2 Z3)

In[]:= ρ20 := D[ρ, Z2]

In[]:= ρ3 := D[ρ, z3]

In[]:= ρ30 := D[ρ, Z3]

In[]:= ρ30

Out[]= -z3 - 2 g z2^2 Z3 - a (-4 z2 z3 Z2 + 2 z3^2 Z3)

In[]:= x2 := e^(i t) s + s^3 (a e^(i t) + 2 a c^2 e^(i t) - 4 i a e^(i t) t)

In[]:= x3 := c * s + (-2 a c - a c^3 - 2 c e^(2 i t) g) * s^3

In[]:= y2 := (x2) / (Exp[I * t] * s)

In[]:= y2

Out[]= 1/s e^(-i t) (e^(i t) s + s^3 (a e^(i t) + 2 a c^2 e^(i t) - 4 i a e^(i t) t))

In[]:= Simplify[1/s e^(-i t) (e^(i t) s + s^3 (a e^(i t) + 2 a c^2 e^(i t) - 4 i a e^(i t) t))]

Out[]= 1 + a s^2 (1 + 2 c^2 - 4 i t)

In[]:= y2 := %

In[]:= y2

In[]:= y2

In[]:= y2 := 1 + a s^2 (1 + 2 c^2 - 4 i t)

In[]:= y2

Out[]= 1 + a s^2 (1 + 2 c^2 - 4 i t)

In[]:= y3 := (x3) / (c * s)

In[]:= y3

Out[]= 1/(c s) (c s + (-2 a c - a c^3 - 2 c e^(2 i t) g) s^3)
```

In[]:= `Simplify[1/(c s) (c s + (-2 a c - a c^3 - 2 c E^(2 I t) g) s^3)]`

Out[]= $1 - a \left(2 + c^2\right) s^2 - 2 e^{2 i t} g s^2$

In[]:= `y3 := 1 - a (2 + c^2) s^2 - 2 E^(2 I t) g s^2`

In[]:= `Collect[1 - a (2 + c^2) s^2 - 2 E^(2 I t) g s^2, s]`

Out[]= $1 + \left(-a \left(2 + c^2\right) - 2 e^{2 i t} g\right) s^2$

In[]:= `y3 := 1 - a (2 + c^2) s^2 - 2 E^(2 I t) g s^2`

In[]:= `y3 := 1 + (-a (2 + c^2) - 2 E^(2 I t) g) s^2`

In[]:= `y3`

Out[]= $1 + \left(-a \left(2 + c^2\right) - 2 e^{2 i t} g\right) s^2$

In[]:= `y2J := 1 + a * J * s^2 (1 + 2 c^2 - 4 I t)`

In[]:= `y2J`

Out[]= $1 + a J s^2 \left(1 + 2 c^2 - 4 i t\right)$

In[]:= `y2`

Out[]= $1 + a s^2 \left(1 + 2 c^2 - 4 i t\right)$

In[]:= `y3J := 1 + (-a (2 + c^2) - 2 E^(2 I t) g) * J * s^2`

In[]:= `A := Sum[b_J * Exp[I * J * t], {J, -6, 6}]`

In[]:= `A`

Out[]= $e^{-6 i t} b_{-6} + e^{-5 i t} b_{-5} + e^{-4 i t} b_{-4} + e^{-3 i t} b_{-3} + e^{-2 i t} b_{-2} + e^{-i t} b_{-1} + b_0 + e^{i t} b_1 + e^{2 i t} b_2 + e^{3 i t} b_3 + e^{4 i t} b_4 + e^{5 i t} b_5 + e^{6 i t} b_6$

In[]:= `dz2 := D[x2, t]`

In[]:= `dz2`

Out[]= $i e^{i t} s + s^3 \left(-3 i a e^{i t} + 2 i a c^2 e^{i t} + 4 a e^{i t} t\right)$

In[]:= `y23`

Out[]= y23

In[]:= `Sum[y2J, {J, -1, 1}]`

Out[]= 3

In[]:= `y2J /. J → 3`

Out[]= $1 + 3 a s^2 \left(1 + 2 c^2 - 4 i t\right)$

In[]:= `y2J /. J → k`

Out[]= $1 + a k s^2 \left(1 + 2 c^2 - 4 i t\right)$

```
In[•]:= I1 := Exp[I * J * t] * y2J * A * dz2

In[•]:= I1

Out[•]= ℯ^(i J t) (1 + a J s^2 (1 + 2 c^2 - 4 i t)) (i ℯ^(i t) s + s^3 (-3 i a ℯ^(i t) + 2 i a c^2 ℯ^(i t) + 4 a ℯ^(i t) t))
        (ℯ^(-6 i t) b_-6 + ℯ^(-5 i t) b_-5 + ℯ^(-4 i t) b_-4 + ℯ^(-3 i t) b_-3 + ℯ^(-2 i t) b_-2 +
          ℯ^(-i t) b_-1 + b_0 + ℯ^(i t) b_1 + ℯ^(2 i t) b_2 + ℯ^(3 i t) b_3 + ℯ^(4 i t) b_4 + ℯ^(5 i t) b_5 + ℯ^(6 i t) b_6)

In[•]:= Simplify[%51]

Out[•]= %51

In[•]:= Expand[%52]

Out[•]= %52

In[•]:= % / s

Out[•]=  %52
         ---
          s

In[•]:= Simplify[%54]

Out[•]= %54

In[•]:= n := Expand[%55]

In[•]:= Collect[%, Exp[I * t]]

In[•]:= % /. J → -Infinity

In[•]:= Collect[%57, Exp[I * J * t]]

Out[•]= %57

In[•]:= n

Out[•]= %55

In[•]:= FullSimplify[%62]

Out[•]= %62

In[•]:= n /. J → 1

Out[•]= %55

In[•]:= Collect[%, Exp[I * t]]

Out[•]= %55

In[•]:= I1new := i b_-2 - 2 i a s^2 b_-2 + 4 i a c^2 s^2 b_-2 - 3 i a^2 s^4 b_-2 - 4 i a^2 c^2 s^4 b_-2 +
          4 i a^2 c^4 s^4 b_-2 + 8 a s^2 t b_-2 - 8 a^2 s^4 t b_-2 + 16 a^2 c^2 s^4 t b_-2 - 16 i a^2 s^4 t^2 b_-2

In[•]:= Collect[I1new, s]

Out[•]= i b_-2 + s^2 (-2 i a b_-2 + 4 i a c^2 b_-2 + 8 a t b_-2) +
        s^4 (-3 i a^2 b_-2 - 4 i a^2 c^2 b_-2 + 4 i a^2 c^4 b_-2 - 8 a^2 t b_-2 + 16 a^2 c^2 t b_-2 - 16 i a^2 t^2 b_-2)
```

In[•]:= **I1new1 := i b$_{-2}$ + s^2 (-2 i a b$_{-2}$ + 4 i a c^2 b$_{-2}$ + 8 a t b$_{-2}$)**

In[•]:= **n /. J → 2**

Out[•]= i b$_{-2}$ - 2 i a s^2 b$_{-2}$ + 4 i a c^2 s^2 b$_{-2}$ - 3 i a^2 s^4 b$_{-2}$ - 4 i a^2 c^2 s^4 b$_{-2}$ +
4 i a^2 c^4 s^4 b$_{-2}$ + 8 a s^2 t b$_{-2}$ - 8 a^2 s^4 t b$_{-2}$ + 16 a^2 c^2 s^4 t b$_{-2}$ - 16 i a^2 s^4 t^2 b$_{-2}$

In[•]:= **Collect[%, Exp[I * t]]**

Out[•]= i b$_{-2}$ - 2 i a s^2 b$_{-2}$ + 4 i a c^2 s^2 b$_{-2}$ - 3 i a^2 s^4 b$_{-2}$ - 4 i a^2 c^2 s^4 b$_{-2}$ +
4 i a^2 c^4 s^4 b$_{-2}$ + 8 a s^2 t b$_{-2}$ - 8 a^2 s^4 t b$_{-2}$ + 16 a^2 c^2 s^4 t b$_{-2}$ - 16 i a^2 s^4 t^2 b$_{-2}$

In[•]:= **i b$_{-3}$ - i a s^2 b$_{-3}$ + 6 i a c^2 s^2 b$_{-3}$ - 6 i a^2 s^4 b$_{-3}$ - 8 i a^2 c^2 s^4 b$_{-3}$ +
8 i a^2 c^4 s^4 b$_{-3}$ + 12 a s^2 t b$_{-3}$ - 16 a^2 s^4 t b$_{-3}$ + 32 a^2 c^2 s^4 t b$_{-3}$ - 32 i a^2 s^4 t^2 b$_{-3}$**

Out[•]= i b$_{-3}$ - i a s^2 b$_{-3}$ + 6 i a c^2 s^2 b$_{-3}$ - 6 i a^2 s^4 b$_{-3}$ - 8 i a^2 c^2 s^4 b$_{-3}$ +
8 i a^2 c^4 s^4 b$_{-3}$ + 12 a s^2 t b$_{-3}$ - 16 a^2 s^4 t b$_{-3}$ + 32 a^2 c^2 s^4 t b$_{-3}$ - 32 i a^2 s^4 t^2 b$_{-3}$

In[•]:= **Collect[%, s]**

Out[•]= i b$_{-3}$ + s^2 (- i a b$_{-3}$ + 6 i a c^2 b$_{-3}$ + 12 a t b$_{-3}$) +
s^4 (- 6 i a^2 b$_{-3}$ - 8 i a^2 c^2 b$_{-3}$ + 8 i a^2 c^4 b$_{-3}$ - 16 a^2 t b$_{-3}$ + 32 a^2 c^2 t b$_{-3}$ - 32 i a^2 t^2 b$_{-3}$)

In[•]:= **I1new2 := i b$_{-3}$ + s^2 (- i a b$_{-3}$ + 6 i a c^2 b$_{-3}$ + 12 a t b$_{-3}$)**

In[•]:= **n /. J → 3**

Out[•]= i b$_{-2}$ - 2 i a s^2 b$_{-2}$ + 4 i a c^2 s^2 b$_{-2}$ - 3 i a^2 s^4 b$_{-2}$ - 4 i a^2 c^2 s^4 b$_{-2}$ +
4 i a^2 c^4 s^4 b$_{-2}$ + 8 a s^2 t b$_{-2}$ - 8 a^2 s^4 t b$_{-2}$ + 16 a^2 c^2 s^4 t b$_{-2}$ - 16 i a^2 s^4 t^2 b$_{-2}$

In[•]:= **Collect[%, Exp[I * t]]**

Out[•]= i b$_{-2}$ - 2 i a s^2 b$_{-2}$ + 4 i a c^2 s^2 b$_{-2}$ - 3 i a^2 s^4 b$_{-2}$ - 4 i a^2 c^2 s^4 b$_{-2}$ +
4 i a^2 c^4 s^4 b$_{-2}$ + 8 a s^2 t b$_{-2}$ - 8 a^2 s^4 t b$_{-2}$ + 16 a^2 c^2 s^4 t b$_{-2}$ - 16 i a^2 s^4 t^2 b$_{-2}$

In[•]:= **i b$_{-4}$ + 8 i a c^2 s^2 b$_{-4}$ - 9 i a^2 s^4 b$_{-4}$ - 12 i a^2 c^2 s^4 b$_{-4}$ + 12 i a^2 c^4 s^4 b$_{-4}$ +
16 a s^2 t b$_{-4}$ - 24 a^2 s^4 t b$_{-4}$ + 48 a^2 c^2 s^4 t b$_{-4}$ - 48 i a^2 s^4 t^2 b$_{-4}$**

Out[•]= i b$_{-4}$ + 8 i a c^2 s^2 b$_{-4}$ - 9 i a^2 s^4 b$_{-4}$ - 12 i a^2 c^2 s^4 b$_{-4}$ + 12 i a^2 c^4 s^4 b$_{-4}$ +
16 a s^2 t b$_{-4}$ - 24 a^2 s^4 t b$_{-4}$ + 48 a^2 c^2 s^4 t b$_{-4}$ - 48 i a^2 s^4 t^2 b$_{-4}$

In[•]:= **Collect[%, s]**

Out[•]= i b$_{-4}$ + s^2 (8 i a c^2 b$_{-4}$ + 16 a t b$_{-4}$) +
s^4 (- 9 i a^2 b$_{-4}$ - 12 i a^2 c^2 b$_{-4}$ + 12 i a^2 c^4 b$_{-4}$ - 24 a^2 t b$_{-4}$ + 48 a^2 c^2 t b$_{-4}$ - 48 i a^2 t^2 b$_{-4}$)

In[•]:= **I1new3 := i b$_{-4}$ + s^2 (8 i a c^2 b$_{-4}$ + 16 a t b$_{-4}$)**

In[•]:= **I1new2**

Out[•]= i b$_{-3}$ + s^2 (- i a b$_{-3}$ + 6 i a c^2 b$_{-3}$ + 12 a t b$_{-3}$)

In[•]:= **I1new3**

Out[•]= i b$_{-4}$ + s^2 (8 i a c^2 b$_{-4}$ + 16 a t b$_{-4}$)

```
In[•]:= i b_-4 + s^2 (8 i a c^2 b_-4 + 16 a t b_-4)
Out[•]= i b_-4 + s^2 (8 i a c^2 b_-4 + 16 a t b_-4)

In[•]:= I1new1
Out[•]= i b_-2 + s^2 (-2 i a b_-2 + 4 i a c^2 b_-2 + 8 a t b_-2)

In[•]:= a := 0

In[•]:= ρ2
Out[•]= -Z_2 - 2 g z_2 Z_3^2

In[•]:= x3
Out[•]= c s - 2 c e^(2 i t) g s^3

In[•]:= X3 := c s - 2 c e^(-2 i t) * G * s^3

In[•]:= x2
Out[•]= e^(i t) s

In[•]:= X2 := s * Exp[-I * t]

In[•]:= q2 := ρ2 /. {z_2 → x2, Z_2 → X2, Z_3 → X3}

In[•]:= q2
Out[•]= -e^(-i t) s - 2 e^(i t) g s (c s - 2 c e^(-2 i t) G s^3)^2

In[•]:= FullSimplify[-e^(-i t) s - 2 e^(i t) g s (c s - 2 c e^(-2 i t) G s^3)^2]
Out[•]= e^(-i t) s (-1 - 2 c^2 e^(2 i t) g (s - 2 e^(-2 i t) G s^3)^2)

In[•]:= Expand[e^(-i t) s (-1 - 2 c^2 e^(2 i t) g (s - 2 e^(-2 i t) G s^3)^2)]
Out[•]= -e^(-i t) s - 2 c^2 e^(i t) g s^3 + 8 c^2 e^(-i t) g G s^5 - 8 c^2 e^(-3 i t) g G^2 s^7

In[•]:= q2t := -e^(-i t) s - 2 c^2 e^(i t) g s^3

In[•]:= I2 := Exp[I * J * t] * y2J * A * dz2 * q2t

In[•]:= I2
Out[•]= i e^(i t+i J t) s (-e^(-i t) s - 2 c^2 e^(i t) g s^3)
        (e^(-6 i t) b_-6 + e^(-5 i t) b_-5 + e^(-4 i t) b_-4 + e^(-3 i t) b_-3 + e^(-2 i t) b_-2 + e^(-i t) b_-1 +
          b_0 + e^(i t) b_1 + e^(2 i t) b_2 + e^(3 i t) b_3 + e^(4 i t) b_4 + e^(5 i t) b_5 + e^(6 i t) b_6)
```

In[•]:= **ExpandAll[%]**

Out[•]= $-i\,e^{-6\,i\,t+i\,J\,t}\,s^2\,b_{-6}-2\,i\,c^2\,e^{-4\,i\,t+i\,J\,t}\,g\,s^4\,b_{-6}-i\,e^{-5\,i\,t+i\,J\,t}\,s^2\,b_{-5}-$
$2\,i\,c^2\,e^{-3\,i\,t+i\,J\,t}\,g\,s^4\,b_{-5}-i\,e^{-4\,i\,t+i\,J\,t}\,s^2\,b_{-4}-2\,i\,c^2\,e^{-2\,i\,t+i\,J\,t}\,g\,s^4\,b_{-4}-$
$i\,e^{-3\,i\,t+i\,J\,t}\,s^2\,b_{-3}-2\,i\,c^2\,e^{-i\,t+i\,J\,t}\,g\,s^4\,b_{-3}-i\,e^{-2\,i\,t+i\,J\,t}\,s^2\,b_{-2}-2\,i\,c^2\,e^{i\,J\,t}\,g\,s^4\,b_{-2}-$
$i\,e^{-i\,t+i\,J\,t}\,s^2\,b_{-1}-2\,i\,c^2\,e^{i\,t+i\,J\,t}\,g\,s^4\,b_{-1}-i\,e^{i\,J\,t}\,s^2\,b_0-2\,i\,c^2\,e^{2\,i\,t+i\,J\,t}\,g\,s^4\,b_0-$
$i\,e^{i\,t+i\,J\,t}\,s^2\,b_1-2\,i\,c^2\,e^{3\,i\,t+i\,J\,t}\,g\,s^4\,b_1-i\,e^{2\,i\,t+i\,J\,t}\,s^2\,b_2-2\,i\,c^2\,e^{4\,i\,t+i\,J\,t}\,g\,s^4\,b_2-$
$i\,e^{3\,i\,t+i\,J\,t}\,s^2\,b_3-2\,i\,c^2\,e^{5\,i\,t+i\,J\,t}\,g\,s^4\,b_3-i\,e^{4\,i\,t+i\,J\,t}\,s^2\,b_4-2\,i\,c^2\,e^{6\,i\,t+i\,J\,t}\,g\,s^4\,b_4-$
$i\,e^{5\,i\,t+i\,J\,t}\,s^2\,b_5-2\,i\,c^2\,e^{7\,i\,t+i\,J\,t}\,g\,s^4\,b_5-i\,e^{6\,i\,t+i\,J\,t}\,s^2\,b_6-2\,i\,c^2\,e^{8\,i\,t+i\,J\,t}\,g\,s^4\,b_6$

In[•]:= **Collect[%, s]**

Out[•]= $s^2\left(-i\,e^{-6\,i\,t+i\,J\,t}\,b_{-6}-i\,e^{-5\,i\,t+i\,J\,t}\,b_{-5}-i\,e^{-4\,i\,t+i\,J\,t}\,b_{-4}-\right.$
$i\,e^{-3\,i\,t+i\,J\,t}\,b_{-3}-i\,e^{-2\,i\,t+i\,J\,t}\,b_{-2}-i\,e^{-i\,t+i\,J\,t}\,b_{-1}-i\,e^{i\,J\,t}\,b_0-i\,e^{i\,t+i\,J\,t}\,b_1-$
$\left.i\,e^{2\,i\,t+i\,J\,t}\,b_2-i\,e^{3\,i\,t+i\,J\,t}\,b_3-i\,e^{4\,i\,t+i\,J\,t}\,b_4-i\,e^{5\,i\,t+i\,J\,t}\,b_5-i\,e^{6\,i\,t+i\,J\,t}\,b_6\right)+$
$s^4\left(-2\,i\,c^2\,e^{-4\,i\,t+i\,J\,t}\,g\,b_{-6}-2\,i\,c^2\,e^{-3\,i\,t+i\,J\,t}\,g\,b_{-5}-2\,i\,c^2\,e^{-2\,i\,t+i\,J\,t}\,g\,b_{-4}-\right.$
$2\,i\,c^2\,e^{-i\,t+i\,J\,t}\,g\,b_{-3}-2\,i\,c^2\,e^{i\,J\,t}\,g\,b_{-2}-2\,i\,c^2\,e^{i\,t+i\,J\,t}\,g\,b_{-1}-2\,i\,c^2\,e^{2\,i\,t+i\,J\,t}\,g\,b_0-$
$2\,i\,c^2\,e^{3\,i\,t+i\,J\,t}\,g\,b_1-2\,i\,c^2\,e^{4\,i\,t+i\,J\,t}\,g\,b_2-2\,i\,c^2\,e^{5\,i\,t+i\,J\,t}\,g\,b_3-$
$\left.2\,i\,c^2\,e^{6\,i\,t+i\,J\,t}\,g\,b_4-2\,i\,c^2\,e^{7\,i\,t+i\,J\,t}\,g\,b_5-2\,i\,c^2\,e^{8\,i\,t+i\,J\,t}\,g\,b_6\right)$

In[•]:= **% / s^2**

Out[•]= $\frac{1}{s^2}\left(s^2\left(-i\,e^{-6\,i\,t+i\,J\,t}\,b_{-6}-i\,e^{-5\,i\,t+i\,J\,t}\,b_{-5}-i\,e^{-4\,i\,t+i\,J\,t}\,b_{-4}-\right.\right.$
$i\,e^{-3\,i\,t+i\,J\,t}\,b_{-3}-i\,e^{-2\,i\,t+i\,J\,t}\,b_{-2}-i\,e^{-i\,t+i\,J\,t}\,b_{-1}-i\,e^{i\,J\,t}\,b_0-i\,e^{i\,t+i\,J\,t}\,b_1-$
$\left.i\,e^{2\,i\,t+i\,J\,t}\,b_2-i\,e^{3\,i\,t+i\,J\,t}\,b_3-i\,e^{4\,i\,t+i\,J\,t}\,b_4-i\,e^{5\,i\,t+i\,J\,t}\,b_5-i\,e^{6\,i\,t+i\,J\,t}\,b_6\right)+$
$s^4\left(-2\,i\,c^2\,e^{-4\,i\,t+i\,J\,t}\,g\,b_{-6}-2\,i\,c^2\,e^{-3\,i\,t+i\,J\,t}\,g\,b_{-5}-2\,i\,c^2\,e^{-2\,i\,t+i\,J\,t}\,g\,b_{-4}-\right.$
$2\,i\,c^2\,e^{-i\,t+i\,J\,t}\,g\,b_{-3}-2\,i\,c^2\,e^{i\,J\,t}\,g\,b_{-2}-2\,i\,c^2\,e^{i\,t+i\,J\,t}\,g\,b_{-1}-2\,i\,c^2\,e^{2\,i\,t+i\,J\,t}\,g\,b_0-$
$2\,i\,c^2\,e^{3\,i\,t+i\,J\,t}\,g\,b_1-2\,i\,c^2\,e^{4\,i\,t+i\,J\,t}\,g\,b_2-2\,i\,c^2\,e^{5\,i\,t+i\,J\,t}\,g\,b_3-$
$\left.\left.2\,i\,c^2\,e^{6\,i\,t+i\,J\,t}\,g\,b_4-2\,i\,c^2\,e^{7\,i\,t+i\,J\,t}\,g\,b_5-2\,i\,c^2\,e^{8\,i\,t+i\,J\,t}\,g\,b_6\right)\right)$

In[•]:= **Simplify[%100]**

Out[•]= %100

In[•]:= **Expand[%101]**

Out[•]= %101

In[•]:= **% /. J → 1**

Out[•]= %101

In[•]:= **Collect[%, Exp[I * t]]**

Out[•]= %101

In[•]:=
```
m := -i e^(i (-6+J) t) b_-6 - 2 i c^2 e^(2 i t+i (-6+J) t) g s^2 b_-6 -
  i e^(i t+i (-6+J) t) b_-5 - 2 i c^2 e^(3 i t+i (-6+J) t) g s^2 b_-5 - i e^(2 i t+i (-6+J) t) b_-4 -
  2 i c^2 e^(4 i t+i (-6+J) t) g s^2 b_-4 - i e^(3 i t+i (-6+J) t) b_-3 - 2 i c^2 e^(5 i t+i (-6+J) t) g s^2 b_-3 -
  i e^(4 i t+i (-6+J) t) b_-2 - 2 i c^2 e^(6 i t+i (-6+J) t) g s^2 b_-2 - i e^(5 i t+i (-6+J) t) b_-1 -
  2 i c^2 e^(7 i t+i (-6+J) t) g s^2 b_-1 - i e^(6 i t+i (-6+J) t) b_0 - 2 i c^2 e^(8 i t+i (-6+J) t) g s^2 b_0 -
  i e^(7 i t+i (-6+J) t) b_1 - 2 i c^2 e^(9 i t+i (-6+J) t) g s^2 b_1 - i e^(8 i t+i (-6+J) t) b_2 -
  2 i c^2 e^(10 i t+i (-6+J) t) g s^2 b_2 - i e^(9 i t+i (-6+J) t) b_3 - 2 i c^2 e^(11 i t+i (-6+J) t) g s^2 b_3 -
  i e^(10 i t+i (-6+J) t) b_4 - 2 i c^2 e^(12 i t+i (-6+J) t) g s^2 b_4 - i e^(11 i t+i (-6+J) t) b_5 -
  2 i c^2 e^(13 i t+i (-6+J) t) g s^2 b_5 - i e^(12 i t+i (-6+J) t) b_6 - 2 i c^2 e^(14 i t+i (-6+J) t) g s^2 b_6
```

In[•]:=
```
m /. J → 2
```

Out[•]=
```
-i e^(-4 i t) b_-6 - 2 i c^2 e^(-2 i t) g s^2 b_-6 - i e^(-3 i t) b_-5 - 2 i c^2 e^(-i t) g s^2 b_-5 - i e^(-2 i t) b_-4 -
 2 i c^2 g s^2 b_-4 - i e^(-i t) b_-3 - 2 i c^2 e^(i t) g s^2 b_-3 - i b_-2 - 2 i c^2 e^(2 i t) g s^2 b_-2 - i e^(i t) b_-1 -
 2 i c^2 e^(3 i t) g s^2 b_-1 - i e^(2 i t) b_0 - 2 i c^2 e^(4 i t) g s^2 b_0 - i e^(3 i t) b_1 - 2 i c^2 e^(5 i t) g s^2 b_1 -
 i e^(4 i t) b_2 - 2 i c^2 e^(6 i t) g s^2 b_2 - i e^(5 i t) b_3 - 2 i c^2 e^(7 i t) g s^2 b_3 - i e^(6 i t) b_4 -
 2 i c^2 e^(8 i t) g s^2 b_4 - i e^(7 i t) b_5 - 2 i c^2 e^(9 i t) g s^2 b_5 - i e^(8 i t) b_6 - 2 i c^2 e^(10 i t) g s^2 b_6
```

In[•]:=
```
Collect[%, Exp[I * t]]
```

Out[•]=
```
-i e^(-4 i t) b_-6 - i e^(-3 i t) b_-5 + e^(-2 i t) (-2 i c^2 g s^2 b_-6 - i b_-4) - 2 i c^2 g s^2 b_-4 +
 e^(-i t) (-2 i c^2 g s^2 b_-5 - i b_-3) - i b_-2 + e^(i t) (-2 i c^2 g s^2 b_-3 - i b_-1) +
 e^(2 i t) (-2 i c^2 g s^2 b_-2 - i b_0) + e^(3 i t) (-2 i c^2 g s^2 b_-1 - i b_1) + e^(4 i t) (-2 i c^2 g s^2 b_0 - i b_2) +
 e^(5 i t) (-2 i c^2 g s^2 b_1 - i b_3) + e^(6 i t) (-2 i c^2 g s^2 b_2 - i b_4) + e^(7 i t) (-2 i c^2 g s^2 b_3 - i b_5) -
 2 i c^2 e^(9 i t) g s^2 b_5 + e^(8 i t) (-2 i c^2 g s^2 b_4 - i b_6) - 2 i c^2 e^(10 i t) g s^2 b_6
```

In[•]:=
```
m /. J → 3
```

Out[•]=
```
-i e^(-3 i t) b_-6 - 2 i c^2 e^(-i t) g s^2 b_-6 - i e^(-2 i t) b_-5 - 2 i c^2 g s^2 b_-5 - i e^(-i t) b_-4 -
 2 i c^2 e^(i t) g s^2 b_-4 - i b_-3 - 2 i c^2 e^(2 i t) g s^2 b_-3 - i e^(i t) b_-2 - 2 i c^2 e^(3 i t) g s^2 b_-2 - i e^(2 i t) b_-1 -
 2 i c^2 e^(4 i t) g s^2 b_-1 - i e^(3 i t) b_0 - 2 i c^2 e^(5 i t) g s^2 b_0 - i e^(4 i t) b_1 - 2 i c^2 e^(6 i t) g s^2 b_1 -
 i e^(5 i t) b_2 - 2 i c^2 e^(7 i t) g s^2 b_2 - i e^(6 i t) b_3 - 2 i c^2 e^(8 i t) g s^2 b_3 - i e^(7 i t) b_4 -
 2 i c^2 e^(9 i t) g s^2 b_4 - i e^(8 i t) b_5 - 2 i c^2 e^(10 i t) g s^2 b_5 - i e^(9 i t) b_6 - 2 i c^2 e^(11 i t) g s^2 b_6
```

In[•]:=
```
Collect[%, Exp[I * t]]
```

Out[•]=
```
-i e^(-3 i t) b_-6 - i e^(-2 i t) b_-5 - 2 i c^2 g s^2 b_-5 + e^(-i t) (-2 i c^2 g s^2 b_-6 - i b_-4) -
 i b_-3 + e^(i t) (-2 i c^2 g s^2 b_-4 - i b_-2) + e^(2 i t) (-2 i c^2 g s^2 b_-3 - i b_-1) +
 e^(3 i t) (-2 i c^2 g s^2 b_-2 - i b_0) + e^(4 i t) (-2 i c^2 g s^2 b_-1 - i b_1) + e^(5 i t) (-2 i c^2 g s^2 b_0 - i b_2) +
 e^(6 i t) (-2 i c^2 g s^2 b_1 - i b_3) + e^(7 i t) (-2 i c^2 g s^2 b_2 - i b_4) + e^(8 i t) (-2 i c^2 g s^2 b_3 - i b_5) -
 2 i c^2 e^(10 i t) g s^2 b_5 + e^(9 i t) (-2 i c^2 g s^2 b_4 - i b_6) - 2 i c^2 e^(11 i t) g s^2 b_6
```

In[•]:=
```
y2J
```

Out[•]=
```
1
```

In[•]:=
```
ρ3
```

Out[•]=
```
-2 G z_3 Z_2^2 - Z_3
```

In[•]:=
```
q3 := ρ3 /. {Z_2 → X2, z_3 → x3, Z_3 → X3}
```

In[•]:= **q3**

Out[•]= $-c\,s+2\,c\,e^{-2\,i\,t}\,G\,s^3-2\,e^{-2\,i\,t}\,G\,s^2\,\left(c\,s-2\,c\,e^{2\,i\,t}\,g\,s^3\right)$

In[•]:= **Simplify[-c s + 2 c e^(-2 i t) G s^3 - 2 e^(-2 i t) G s^2 (c s - 2 c e^(2 i t) g s^3)]**

Out[•]= $c\,s\,\left(-1+4\,g\,G\,s^4\right)$

In[•]:= **ρ3**

Out[•]= $z_1+Z_1-z_2\,Z_2-G\,z_3^2\,Z_2^2-z_3\,Z_3-g\,z_2^2\,Z_{33}^2$

In[•]:= **ρ3**

Out[•]= $-2\,G\,z_3\,Z_2^2-Z_3$

In[•]:= **x2**

Out[•]= $e^{i\,t}\,s$

In[•]:= **X2**

Out[•]= $e^{-i\,t}\,s$

In[•]:= **x3**

Out[•]= $c\,s-2\,c\,e^{2\,i\,t}\,g\,s^3$

In[•]:= **X3**

Out[•]= $c\,s-2\,c\,e^{-2\,i\,t}\,G\,s^3$

In[•]:= **X3n := k * s - 2 k e^(-2 i t) * G * s^3**

In[•]:= **q3 := ρ3 /. {Z_2 → X2, z_3 → x3, Z_3 → X3n}**

In[•]:= **q3**

Out[•]= $-k\,s+2\,e^{-2\,i\,t}\,G\,k\,s^3-2\,e^{-2\,i\,t}\,G\,s^2\,\left(c\,s-2\,c\,e^{2\,i\,t}\,g\,s^3\right)$

In[•]:= **Simplify[-k s + 2 e^(-2 i t) G k s^3 - 2 e^(-2 i t) G s^2 (c s - 2 c e^(2 i t) g s^3)]**

Out[•]= $-k\,s+2\,e^{-2\,i\,t}\,G\,\left(-c+k\right)\,s^3+4\,c\,g\,G\,s^5$

In[•]:= **q3t := -k s + 2 e^(-2 i t) G (-c + k) s^3**

In[•]:= **I3 := (Exp[I * J * t] * y2J * A * dz2 * q3t) / s^2**

In[•]:= **I3**

Out[•]= $\frac{1}{s}\,i\,e^{i\,t+i\,J\,t}\,\left(-k\,s+2\,e^{-2\,i\,t}\,G\,\left(-c+k\right)\,s^3\right)\,\left(e^{-6\,i\,t}\,b_{-6}+e^{-5\,i\,t}\,b_{-5}+e^{-4\,i\,t}\,b_{-4}+e^{-3\,i\,t}\,b_{-3}+e^{-2\,i\,t}\,b_{-2}+e^{-i\,t}\,b_{-1}+b_0+e^{i\,t}\,b_1+e^{2\,i\,t}\,b_2+e^{3\,i\,t}\,b_3+e^{4\,i\,t}\,b_4+e^{5\,i\,t}\,b_5+e^{6\,i\,t}\,b_6\right)$

In[•]:= **Simplify[%112]**

Out[•]= $-i\,e^{i\,(-7+J)\,t}\,\left(e^{2\,i\,t}\,k+2\,G\,\left(c-k\right)\,s^2\right)\,\left(b_{-6}+e^{i\,t}\,b_{-5}+e^{2\,i\,t}\,b_{-4}+e^{3\,i\,t}\left(b_{-3}+e^{i\,t}\,b_{-2}+e^{2\,i\,t}\,b_{-1}+e^{3\,i\,t}\,b_0+e^{4\,i\,t}\,b_1+e^{5\,i\,t}\,b_2+e^{6\,i\,t}\,b_3+e^{7\,i\,t}\,b_4+e^{8\,i\,t}\,b_5+e^{9\,i\,t}\,b_6\right)\right)$

In[•]:= **Expand[%]**

Out[•]= $$-i\, e^{2 i t+i (-7+J) t} k\, b_{-6}-2 i c\, e^{i (-7+J) t} G s^2 b_{-6}+2 i\, e^{i (-7+J) t} G k s^2 b_{-6}-$$
$$i\, e^{3 i t+i (-7+J) t} k\, b_{-5}-2 i c\, e^{i t+i (-7+J) t} G s^2 b_{-5}+2 i\, e^{i t+i (-7+J) t} G k s^2 b_{-5}-$$
$$i\, e^{4 i t+i (-7+J) t} k\, b_{-4}-2 i c\, e^{2 i t+i (-7+J) t} G s^2 b_{-4}+2 i\, e^{2 i t+i (-7+J) t} G k s^2 b_{-4}-$$
$$i\, e^{5 i t+i (-7+J) t} k\, b_{-3}-2 i c\, e^{3 i t+i (-7+J) t} G s^2 b_{-3}+2 i\, e^{3 i t+i (-7+J) t} G k s^2 b_{-3}-$$
$$i\, e^{6 i t+i (-7+J) t} k\, b_{-2}-2 i c\, e^{4 i t+i (-7+J) t} G s^2 b_{-2}+2 i\, e^{4 i t+i (-7+J) t} G k s^2 b_{-2}-$$
$$i\, e^{7 i t+i (-7+J) t} k\, b_{-1}-2 i c\, e^{5 i t+i (-7+J) t} G s^2 b_{-1}+2 i\, e^{5 i t+i (-7+J) t} G k s^2 b_{-1}-$$
$$i\, e^{8 i t+i (-7+J) t} k\, b_0-2 i c\, e^{6 i t+i (-7+J) t} G s^2 b_0+2 i\, e^{6 i t+i (-7+J) t} G k s^2 b_0-$$
$$i\, e^{9 i t+i (-7+J) t} k\, b_1-2 i c\, e^{7 i t+i (-7+J) t} G s^2 b_1+2 i\, e^{7 i t+i (-7+J) t} G k s^2 b_1-$$
$$i\, e^{10 i t+i (-7+J) t} k\, b_2-2 i c\, e^{8 i t+i (-7+J) t} G s^2 b_2+2 i\, e^{8 i t+i (-7+J) t} G k s^2 b_2-$$
$$i\, e^{11 i t+i (-7+J) t} k\, b_3-2 i c\, e^{9 i t+i (-7+J) t} G s^2 b_3+2 i\, e^{9 i t+i (-7+J) t} G k s^2 b_3-$$
$$i\, e^{12 i t+i (-7+J) t} k\, b_4-2 i c\, e^{10 i t+i (-7+J) t} G s^2 b_4+2 i\, e^{10 i t+i (-7+J) t} G k s^2 b_4-$$
$$i\, e^{13 i t+i (-7+J) t} k\, b_5-2 i c\, e^{11 i t+i (-7+J) t} G s^2 b_5+2 i\, e^{11 i t+i (-7+J) t} G k s^2 b_5-$$
$$i\, e^{14 i t+i (-7+J) t} k\, b_6-2 i c\, e^{12 i t+i (-7+J) t} G s^2 b_6+2 i\, e^{12 i t+i (-7+J) t} G k s^2 b_6$$

In[•]:= **Simplify[%]**

Out[•]= $$-i\, e^{i (-7+J) t} \left(e^{2 i t} k+2 G \left(c-k\right) s^2\right) \left(b_{-6}+e^{i t} b_{-5}+e^{2 i t} b_{-4}+e^{3 i t}\right.$$
$$\left.\left(b_{-3}+e^{i t} b_{-2}+e^{2 i t} b_{-1}+e^{3 i t} b_0+e^{4 i t} b_1+e^{5 i t} b_2+e^{6 i t} b_3+e^{7 i t} b_4+e^{8 i t} b_5+e^{9 i t} b_6\right)\right)$$

In[•]:= **Expand[%]**

Out[•]= $$-i\, e^{2 i t+i (-7+J) t} k\, b_{-6}-2 i c\, e^{i (-7+J) t} G s^2 b_{-6}+2 i\, e^{i (-7+J) t} G k s^2 b_{-6}-$$
$$i\, e^{3 i t+i (-7+J) t} k\, b_{-5}-2 i c\, e^{i t+i (-7+J) t} G s^2 b_{-5}+2 i\, e^{i t+i (-7+J) t} G k s^2 b_{-5}-$$
$$i\, e^{4 i t+i (-7+J) t} k\, b_{-4}-2 i c\, e^{2 i t+i (-7+J) t} G s^2 b_{-4}+2 i\, e^{2 i t+i (-7+J) t} G k s^2 b_{-4}-$$
$$i\, e^{5 i t+i (-7+J) t} k\, b_{-3}-2 i c\, e^{3 i t+i (-7+J) t} G s^2 b_{-3}+2 i\, e^{3 i t+i (-7+J) t} G k s^2 b_{-3}-$$
$$i\, e^{6 i t+i (-7+J) t} k\, b_{-2}-2 i c\, e^{4 i t+i (-7+J) t} G s^2 b_{-2}+2 i\, e^{4 i t+i (-7+J) t} G k s^2 b_{-2}-$$
$$i\, e^{7 i t+i (-7+J) t} k\, b_{-1}-2 i c\, e^{5 i t+i (-7+J) t} G s^2 b_{-1}+2 i\, e^{5 i t+i (-7+J) t} G k s^2 b_{-1}-$$
$$i\, e^{8 i t+i (-7+J) t} k\, b_0-2 i c\, e^{6 i t+i (-7+J) t} G s^2 b_0+2 i\, e^{6 i t+i (-7+J) t} G k s^2 b_0-$$
$$i\, e^{9 i t+i (-7+J) t} k\, b_1-2 i c\, e^{7 i t+i (-7+J) t} G s^2 b_1+2 i\, e^{7 i t+i (-7+J) t} G k s^2 b_1-$$
$$i\, e^{10 i t+i (-7+J) t} k\, b_2-2 i c\, e^{8 i t+i (-7+J) t} G s^2 b_2+2 i\, e^{8 i t+i (-7+J) t} G k s^2 b_2-$$
$$i\, e^{11 i t+i (-7+J) t} k\, b_3-2 i c\, e^{9 i t+i (-7+J) t} G s^2 b_3+2 i\, e^{9 i t+i (-7+J) t} G k s^2 b_3-$$
$$i\, e^{12 i t+i (-7+J) t} k\, b_4-2 i c\, e^{10 i t+i (-7+J) t} G s^2 b_4+2 i\, e^{10 i t+i (-7+J) t} G k s^2 b_4-$$
$$i\, e^{13 i t+i (-7+J) t} k\, b_5-2 i c\, e^{11 i t+i (-7+J) t} G s^2 b_5+2 i\, e^{11 i t+i (-7+J) t} G k s^2 b_5-$$
$$i\, e^{14 i t+i (-7+J) t} k\, b_6-2 i c\, e^{12 i t+i (-7+J) t} G s^2 b_6+2 i\, e^{12 i t+i (-7+J) t} G k s^2 b_6$$

In[•]:= **% /. J → 1**

Out[•]= $$-i\, e^{-4 i t} k\, b_{-6}-2 i c\, e^{-6 i t} G s^2 b_{-6}+2 i\, e^{-6 i t} G k s^2 b_{-6}-i\, e^{-3 i t} k\, b_{-5}-2 i c\, e^{-5 i t} G s^2 b_{-5}+$$
$$2 i\, e^{-5 i t} G k s^2 b_{-5}-i\, e^{-2 i t} k\, b_{-4}-2 i c\, e^{-4 i t} G s^2 b_{-4}+2 i\, e^{-4 i t} G k s^2 b_{-4}-$$
$$i\, e^{-i t} k\, b_{-3}-2 i c\, e^{-3 i t} G s^2 b_{-3}+2 i\, e^{-3 i t} G k s^2 b_{-3}-i k\, b_{-2}-2 i c\, e^{-2 i t} G s^2 b_{-2}+$$
$$2 i\, e^{-2 i t} G k s^2 b_{-2}-i\, e^{i t} k\, b_{-1}-2 i c\, e^{-i t} G s^2 b_{-1}+2 i\, e^{-i t} G k s^2 b_{-1}-i\, e^{2 i t} k\, b_0-$$
$$2 i c G s^2 b_0+2 i G k s^2 b_0-i\, e^{3 i t} k\, b_1-2 i c\, e^{i t} G s^2 b_1+2 i\, e^{i t} G k s^2 b_1-$$
$$i\, e^{4 i t} k\, b_2-2 i c\, e^{2 i t} G s^2 b_2+2 i\, e^{2 i t} G k s^2 b_2-i\, e^{5 i t} k\, b_3-2 i c\, e^{3 i t} G s^2 b_3+$$
$$2 i\, e^{3 i t} G k s^2 b_3-i\, e^{6 i t} k\, b_4-2 i c\, e^{4 i t} G s^2 b_4+2 i\, e^{4 i t} G k s^2 b_4-i\, e^{7 i t} k\, b_5-$$
$$2 i c\, e^{5 i t} G s^2 b_5+2 i\, e^{5 i t} G k s^2 b_5-i\, e^{8 i t} k\, b_6-2 i c\, e^{6 i t} G s^2 b_6+2 i\, e^{6 i t} G k s^2 b_6$$

In[•]:=
```
Collect[%, Exp[I * t]]
```

Out[•]=
$$e^{-6 i t} \left(-2 i c G s^2 b_{-6} + 2 i G k s^2 b_{-6}\right) + e^{-5 i t} \left(-2 i c G s^2 b_{-5} + 2 i G k s^2 b_{-5}\right) + e^{-4 i t} \left(-i k b_{-6} - 2 i c G s^2 b_{-4} + 2 i G k s^2 b_{-4}\right) + e^{-3 i t} \left(-i k b_{-5} - 2 i c G s^2 b_{-3} + 2 i G k s^2 b_{-3}\right) - i k b_{-2} + e^{-2 i t} \left(-i k b_{-4} - 2 i c G s^2 b_{-2} + 2 i G k s^2 b_{-2}\right) + e^{-i t} \left(-i k b_{-3} - 2 i c G s^2 b_{-1} + 2 i G k s^2 b_{-1}\right) - 2 i c G s^2 b_0 + 2 i G k s^2 b_0 + e^{i t} \left(-i k b_{-1} - 2 i c G s^2 b_1 + 2 i G k s^2 b_1\right) + e^{2 i t} \left(-i k b_0 - 2 i c G s^2 b_2 + 2 i G k s^2 b_2\right) + e^{3 i t} \left(-i k b_1 - 2 i c G s^2 b_3 + 2 i G k s^2 b_3\right) + e^{4 i t} \left(-i k b_2 - 2 i c G s^2 b_4 + 2 i G k s^2 b_4\right) - i e^{7 i t} k b_5 + e^{5 i t} \left(-i k b_3 - 2 i c G s^2 b_5 + 2 i G k s^2 b_5\right) - i e^{8 i t} k b_6 + e^{6 i t} \left(-i k b_4 - 2 i c G s^2 b_6 + 2 i G k s^2 b_6\right)$$

In[•]:=
```
% / s^2
```

Out[•]=
$$\frac{1}{s^2} \left(e^{-6 i t} \left(-2 i c G s^2 b_{-6} + 2 i G k s^2 b_{-6}\right) + e^{-5 i t} \left(-2 i c G s^2 b_{-5} + 2 i G k s^2 b_{-5}\right) + e^{-4 i t} \left(-i k b_{-6} - 2 i c G s^2 b_{-4} + 2 i G k s^2 b_{-4}\right) + e^{-3 i t} \left(-i k b_{-5} - 2 i c G s^2 b_{-3} + 2 i G k s^2 b_{-3}\right) - i k b_{-2} + e^{-2 i t} \left(-i k b_{-4} - 2 i c G s^2 b_{-2} + 2 i G k s^2 b_{-2}\right) + e^{-i t} \left(-i k b_{-3} - 2 i c G s^2 b_{-1} + 2 i G k s^2 b_{-1}\right) - 2 i c G s^2 b_0 + 2 i G k s^2 b_0 + e^{i t} \left(-i k b_{-1} - 2 i c G s^2 b_1 + 2 i G k s^2 b_1\right) + e^{2 i t} \left(-i k b_0 - 2 i c G s^2 b_2 + 2 i G k s^2 b_2\right) + e^{3 i t} \left(-i k b_1 - 2 i c G s^2 b_3 + 2 i G k s^2 b_3\right) + e^{4 i t} \left(-i k b_2 - 2 i c G s^2 b_4 + 2 i G k s^2 b_4\right) - i e^{7 i t} k b_5 + e^{5 i t} \left(-i k b_3 - 2 i c G s^2 b_5 + 2 i G k s^2 b_5\right) - i e^{8 i t} k b_6 + e^{6 i t} \left(-i k b_4 - 2 i c G s^2 b_6 + 2 i G k s^2 b_6\right)\right)$$

In[•]:=
```
Simplify[%]
```

Out[•]=
$$-\frac{1}{s^2} i e^{-6 i t} \left(e^{2 i t} k + 2 G \left(c - k\right) s^2\right) \left(b_{-6} + e^{i t} b_{-5} + e^{2 i t} b_{-4} + e^{3 i t} \left(b_{-3} + e^{i t} b_{-2} + e^{2 i t} b_{-1} + e^{3 i t} b_0 + e^{4 i t} b_1 + e^{5 i t} b_2 + e^{6 i t} b_3 + e^{7 i t} b_4 + e^{8 i t} b_5 + e^{9 i t} b_6\right)\right)$$

In[•]:=
```
Ahmad := %139
```

In[•]:=
```
Ahmad
```

Out[•]=
```
%139
```

In[•]:=
```
Ahmad /. J → 1
```

Out[•]=
```
%139
```

In[•]:=
```
Collect[%, Exp[I * t]]
```

Out[•]=
```
%139
```