31
We will reflect all impedances to the middle (Theta 2), since we wish to find the transfer funtion O2(s)/T(s).

The following reflections are made:

T(s) reflects to T(s)*(12/4) = 3 T(s)
J1 reflects to J1*(12/4)^2 = 9 J1
D1 reflects to D1*(12/4)^2 = 9 D1
D3 reflects to D3*(4/16)^2 = D3/16
J3 reflects to J3*(4/16)^2 = J3/16
K reflects to K*(4/16)^2 = K/16

We then have a total J of
     Jtotal = 9 J1 + J2 + J3/16 = 20
And analogously,
     Dtotal = 9 D1 + D2 + D3/16 = 13
     Ktotal = K/16 = 4

We can then write the equation of motion as

O2(s) * [Jtotal s^2 + Dtotal s + Ktotal] = 3 T(s), or

```
O2(s)          3
----- = ----------------
 T(s)    20s^2 + 13s + 4
```

%%%
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We will once again reflect the imedances to O2(s), since it is the output in question.

We then find that

O2(s)[200+ 3*(50/5)^2]s^2 + 1000s +
250(50/5*5/25)^2]=T(s)*(50/5)

Note that the spring, k, was reflected through two sets of gears, the (5/25)^2 term and the (50/5)^2.

It is clear now that

```
O2(s)           (1/50)
-----  =  -----------------
T(s)         s^2 + 2s + 2
```

A second order system!

33. One can show that the transfer function is

.8/(s+1)