**Matrix Dynamic Analysis for Four Bar**

The four bar linkage shown below operates in a vertical plane. Each link is a uniform bar with 2 cm by 2 cm square cross-section stainless steel. Assume that the masses of the bearings and the effects of friction are negligible. Do not neglect the effects of gravity.

θ2 = 45 deg ω2 = 20 rad/s CW α2 = 100 rad/s/s CCW

θ3 = 20 deg ω3 = 12.82 rad/s CCW α3 = 39.6 rad/s/s CW

θ4 = 117.4 deg ω4 = 6.20 rad/s CW α4 = 482.5 rad/s/s CCW

m2 = 0.248 kg JG2’ = 1.405 kg.cm2  = 7.75 g/cm3

m3 = 0.372 kg JG3’ = 4.588 kg.cm2

m4 = 0.341 kg JG4’ = 3.552 kg.cm2

VG2 = 56.57 - j 56.57 cps AG2 = -1414.2 - j 848.5 cps2

VG3 = 86.83 - j 40.86 cps AG3 = -3672.5 - j 2260.9 cps2

VG4 = 30.27 - j 15.71 cps AG4 = -2262.4 - j 1412.4 cps2







A

D

X

C

B

Y

T

AD = 22 cm

AB = 8 cm

BC = 12 cm

CD = 11 cm

D

C

F14y

F14x

F34y

F34x

G4

W4

RD4/G4

RC4/G4

A

B

F32y

F32x

F12y

F12x

G2

W2

RA2/G2

RB2/G2

T12

C

B

F43y

F43x

F23y

F23x

G3

W3

RB3/G3

RC3/G3

**F on 2 right +** F12x + F32x = m2 AG2x

# **F on 2 up +** F12y + F32y + W2 = m2 AG2y

**M on 2 about G2 CCW +** - F12x rA2/G2y + F12y rA2/G2x - F32x rB2/G2y + F32y rB2/G2x + T12 = JG2’ 2

# **F on 3 right +** F23x + F43x = m3 AG3x

# **F on 3 up +** F23y + F43y + W3 = m2 AG3y

**M on 3 about G3 CCW +** - F23x rB3/G3y + F23y rB3/G3x - F43x rC3/G3y + F43y rC3/G3x = JG3’ 3

# **F on 4 right +** F34x + F14x = m4 AG4x

# **F on 4 up +** F34y + F14y + W4 = m4 AG4y

**M on 4 about G4 CCW +** - F34x rC4/G4y + F34y rC4/G4x - F14x rD4/G4y + F14y rD4/G4x = JG4’ 4



W2 = -j 2.433 N m2 AG2 = -3.507 - j 2.104 N JG2’ 2 = 1.405 N.cm

W3 = -j 3.649 N m3 AG3 = -13.662 - j 8.411 N JG3’ 3 = -1.817 N.cm

W4 = -j 3.345 N m4 AG4 = -7.715 - j 4.816 N JG4’ 4 = 17.138 N.cm





**Matrix Dynamic Analysis for Slider Crank**

1

1

2

3

4

A

B





**P**

**T12**

G3

C

2

G2 = A

B



**T12**



**F32y**

**F12y**

**F12x**

**F32x**

4

**F14x**

**F14y**

+ direction for

VC to right

**F34y**

**F34x**

C

**P**



B

3

**F23x**

C

**F43y**

**F43x**

G3



**F23y**

**F on 2 right +** F12x + F32x = m2 AG2x = 0

# **F on 2 up +** F12y + F32y = m2 AG2y = 0

**M on 2 about A CCW +** - (F32x sin) AB + (F32y cos) AB + T12 = JG2 2

# **F on 3 right +** F23x + F43x = m3 AG3x

# **F on 3 up +** F23y + F43y = m3 AG3y

**M on 3 about G3  CCW +** - (F23x sin) BG3 - (F23y cos) BG3

+ (F43x sin) CG3 + (F43y cos) CG3 = JG3 3

# **F on 4 right +** F14x + F34x + P = m4 AG4x

# **F on 4 up +** F14y + F34y = m4 AG4y = 0

**friction** F14x = -  abs(F14y) sign(VC)

