2 (cont'd)

KINEMATICS

From (i) & (iii) with $\omega_{33} = 0$ and $\omega_a = 1450$ rpm

$\Rightarrow$ $\omega_p = 4441$ rpm, $\omega_{31} = 2.923$ rpm } both positive ∴ clockwise.

KINETICS

From (ii) & (iv) with the constraints

$$\begin{cases} T_{p1} + T_{p2} = 0 \\ T_{a1} + T_{a2} = T_a = (P/\omega)_A \\ \qquad = 5 \times 10^3 / 2\pi \frac{1450}{60} = 32.9 \text{ Nm} \end{cases}$$

$\Rightarrow$ $T_{a1} = 16 \times 46\, T_a = 24.2$ kNm

$\Rightarrow$ $T_{33} = -\frac{33}{49} T_{a2} = -\frac{33}{49}(32.9 - 24.2 \times 10^3)$

$= +16.3$ kN ie. 16.3 kN clockwise.

3

Radius to B planet shaft $= R_A + R_B = R_C - R_B$ ∴ $z_C = 70$

" " E " " $= R_D + R_E = R_F - R_E$ ∴ $z_F = 68$

Call output arm/shaft 'G'.

Apply $(\omega_S - \omega_a) z_S + (\omega_P - \omega_a) z_P = 0$

to
- ABF : $(\omega_A - \omega_F) 30 + (\omega_B - \omega_F) 20 = 0$
- CBF : $(\omega_C - \omega_F)(-70) + (\omega_B - \omega_F) 20 = 0$
- DEG : $(\omega_D - \omega_G) 32 + (\omega_E - \omega_G) 18 = 0$
- FEG : $(\omega_F - \omega_G)(-68) + (\omega_E - \omega_G) 18 = 0$

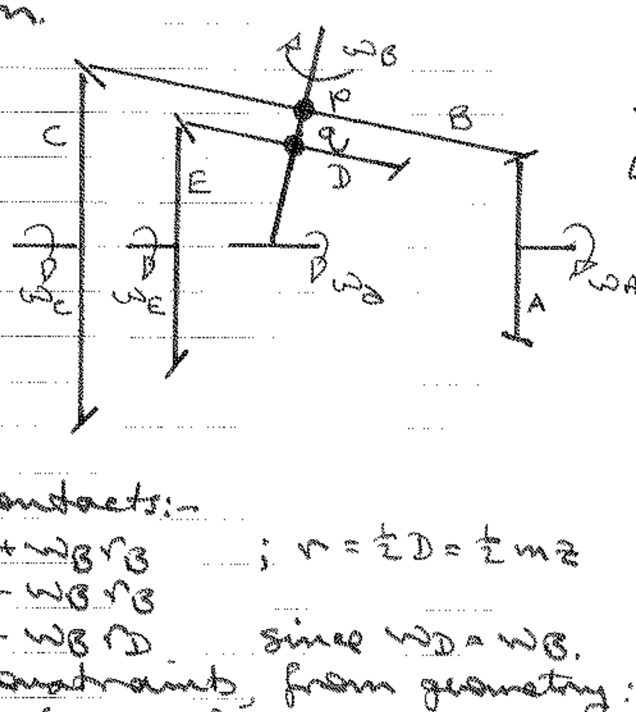
Assume positive clockwise, so $\omega_A = \omega_D = 1000$ rpm

Solve, given also that $\omega_C = 0$ to obtain $\omega_G = 524$.

∴ Output shaft rotates at 524 rpm, in same sense as input shaft rotation.

4

We cannot apply the basic equation, but have to revert to relative motion concepts at gear contacts, together with geometric constraints. Let rotational speeds be as shown, ω_a being that of the arm. Let points p, q be the centres of B, D on arm.



For no slip at the gear contacts:-

- A-B: $\omega_A r_A = \omega_a r_p + \omega_B r_B$; $r = \frac{1}{2} D = \frac{1}{2} m z$
- B-C: $\omega_C r_C = \omega_a r_p - \omega_B r_B$
- D-E: $\omega_E r_E = \omega_a r_q - \omega_B r_D$ since $\omega_D = \omega_B$.

The necessary geometric constraints, from geometry:

$r_p = \frac{1}{2}(r_A + r_C) = \frac{1}{2} \cdot \frac{1}{2} m_{ABC} (z_A + z_C)$

& $(r_E - r_q)/r_D = (r_C - r_A)/2 r_B$ — whence

$r_q = \frac{1}{2} m_{DE} [z_E - (z_C - z_A) z_D / 2 z_B]$