

Engineering Tripos Part IIA 2018 - 3C8 Machine Design – Numerical Answers

1. (b)  $1.72 \text{ GN m}^{-2}$ ,  $11.1 \text{ }\mu\text{m}$ 
  - (c)  $2.25 \text{ GN m}^{-2}$
  - (d) incorrect
  
2. (a) (i)  $\omega_t = -\Omega_2 \frac{R_1 R_2}{r(R_1 + R_2)}$ 
  - (ii)  $\Delta\omega_1 = -\frac{\Omega_2}{\sqrt{2}} \frac{R_2}{R_1 + R_2} - \omega_n$   
 $\Delta\omega_2 = \frac{\Omega_2}{\sqrt{2}} \frac{R_1}{R_1 + R_2} - \omega_n$
  - (iii)  $-\frac{\Omega_2}{\sqrt{2}} \frac{R_2}{R_1 + R_2} < \omega_n < \frac{\Omega_2}{\sqrt{2}} \frac{R_1}{R_1 + R_2}$
  
- (b) lowest ball 177 N, adjacent balls 125 N
  
3. (b) output speed  $600 \text{ rad s}^{-1}$   
motor A torque  $-20 \text{ N m}$   
motor B torque  $-16 \text{ N m}$ 
  - (c) output torque  $400 \text{ N m}$   
motor A speed  $-180 \text{ rad s}^{-1}$   
motor B speed  $360 \text{ rad s}^{-1}$
  
4. (b) (i)  $4.5 \text{ MN m}$ ,  $2.23 \text{ GN m}^{-2}$ 
  - (ii)  $3.0 \text{ MN m}$ ,  $2.5 \text{ GN m}^{-2}$
  - (iii) 12 teeth,  $3.0 \text{ MN m}$ ,  $2.73 \text{ GN m}^{-2}$