

## Clutches Tutorial Sheet

1. A plate clutch has 3 driving discs and 2 driven discs, i.e. 4 pairs of contact surfaces, each of 240 mm external diameter and 120 mm internal diameter.
  - (a) Assuming uniform pressure, calculate the total axial spring load required to permit the clutch to transmit 25 kW at 1575 rev/min if the coefficient of friction between the disc surfaces is 0.3.
  - (b) If there are 6 springs, each of stiffness  $13 \text{ kNm}^{-1}$ , and each of the contact surfaces has lost 1.25 mm due to wear, calculate the maximum power which can be transmitted under the above conditions.
2. A cone clutch is designed to transmit 27 kW of power at 1240 rpm. The clutch contact surfaces have an outer diameter of 350 mm and the semi-cone angle is  $10^\circ$ . Assuming the face width is 65 mm and the coefficient of friction is 0.24, determine the axial force required to transmit the torque assuming:
  - (a) uniform pressure;
  - (b) uniform wear.
3. A cone clutch has inner and outer radii of 122 mm and 152.5 mm respectively, with a semi-cone angle being  $20^\circ$ . If the coefficient of friction is 0.25 and the allowable uniform normal pressure is  $138 \text{ kNm}^{-2}$ , determine:
  - (a) the necessary axial load;
  - (b) the power that can be transmitted at 1000 rev/min.
4. A multiplate clutch is to transmit 11.2 kW at 1500 rev/min. The inner and outer radii for the plates are 51 mm and 101.5 mm respectively. The maximum axial spring force is restricted to 980 N.
  - (a) Calculate the necessary number of pairs of surfaces if  $\mu = 0.35$  (assuming uniform pressure).
  - (b) What will be the necessary axial force?
5. A multiple disc clutch has 6 pairs of contact surfaces, each having inner diameter of 110 mm and external diameter of 250 mm. The coefficient of friction between clutch plate surfaces is 0.3.
  - i) Determine the total axial load required to permit the clutch to transmit a power of 50 kW at speed of 1800 rev/min, assuming uniform pressure.
  - ii) Determine the power that can be transmitted when each of the contact surfaces has lost 1.25 mm due to wear if eight springs, each of stiffness  $7 \text{ kNm}^{-1}$ , are used to provide the axial load.

6. A cone clutch is employed to connect an electric motor to a flywheel. The motor runs at a steady speed of 1400 rev/min. The clutch contact surfaces have inner and outer radii of 50 mm and 120 mm respectively and it has a semi-cone angle of  $15^\circ$ . The flywheel has a mass of 15 kg and a radius of gyration of 180 mm. If the coefficient of friction between the clutch contact surfaces is 0.31, determine:
- i) the maximum power that can be transmitted by the clutch when the applied axial force is 420 N, assuming uniform wear;
  - ii) the time required and the number of revolutions made by the flywheel before reaching full speed, assuming starting from rest.

**Tutorial : Clutch Drive System Design - Answers**

1. (a) 1353.21 N ; (b) 10.21 kW
2. (a) 887.06 N ; (b) 888.36 N
3. (a) 3.63 kN; (b) 38.29 kW
4. (a) 3; (b) 859 N
5. i) 1559 N; ii) 21.96 kW
6. i) 6.27 kW; ii) 1.67 s; 19.44 revs