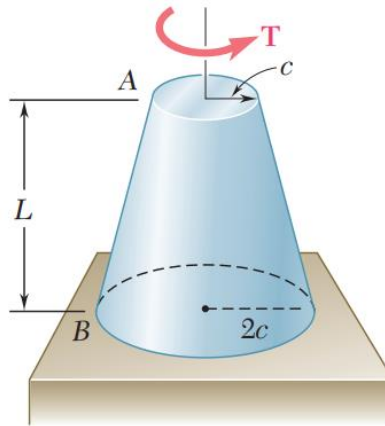


**Tutorial (Date: 09/06/2023)**

Q.1 A torque  $T$  is applied as shown to a solid tapered shaft  $AB$ . Show by integration that the angle of

twist at  $A$  is, 
$$\phi = \frac{7TL}{12\pi Gc^4}$$



Q.2 A solid circular shaft has a uniform diameter of 5 cm and is 4 m long. At the midpoint 65 hp is delivered to the shaft by means of a belt passing over a pulley. This power is used to drive two machines, one at the left end of the shaft consuming 25 hp and one at the right end consuming the remaining 40 hp. Determine the maximum shearing stress in the shaft and also the relative angle of twist between the two extreme ends of the shaft. The shaft turns at 200 rpm and the material is steel for which  $G = 80$  GPa.

Q.3 A steel shaft  $ABC$ , of constant circular cross section and of diameter 80 mm, clamped at the left end  $A$ , loaded by a twisting moment of 6000 N.m at its mid-point  $B$ , and elastically restrained against twisting at the right end  $C$  (see below figure). At the end  $C$ , the shaft  $ABC$  is attached to vertical steel bars each of 16 mm diameter. The upper bar  $MN$  is attached to the end  $N$  of a horizontal diameter of the 80 mm shaft  $ABC$  and the lower bar  $PQ$  is to the other end  $Q$  of this same horizontal diameter, as shown in below figure. For all materials  $E = 200$  GPa and  $G = 80$  GPa. Determine the peak shearing stress in bar  $ABC$  as well as the tensile stress in bar  $MN$ .

